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APRIL, 1918

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NOTES ON SHIPBUILDING

A Statement of the Primary Requirements for Successfully Building and Launching Vessels, Particularly in the South, One of the Vital Factors of the War

By F. J. FRENCH,[1] NEW ORLEANS, LA.

I HAVE been asked to outline, in as few words as possible, the problems which present themselves to the prospective shipbuilder, rather with a view to promoting discussion on the subject with especial reference to local conditions in the South than with any intent to disseminate uninteresting and unimportant data on the subject of design.

Let us assume first that the shipyard owner is approached by a client who desires a vessel built for his particular service. His requirements will be primarily governed by ships that he already has in service; modified by the recommendations of his marine superintendent and his port engineer as to type of cargo, desired carrying capacity, draft, speed, and indicated horsepower, and further modified by that very misleading factor, "cost per deadweight ton," which is so widely quoted, regardless of speed required.

To illustrate the fallacy of using this unit of cost, take a vessel of 5000 tons deadweight capacity and assume, from data already at hand, a speed of 10 knots with an indicated horsepower of 1500. If the owner desires his ship to make 13 knots instead of 10, it will be found that (as for normal speeds the power varies with the cube of the speed) the required indicated horsepower will be in the neighborhood of 3300, or more than double the original figure, and the power-plant weight and cost will, of course, be in similar proportion.

The primary characteristics having been decided upon, the problem now passes to the builder's naval architect, who correlates all of the factors determined upon by the principles and sends to the estimator the weights, horsepower, etc., who in turn makes an estimate of cost upon which the contract is finally signed. It goes without saying that the estimate takes into full account whether or not the vessel is for bulk oil or molasses, which requires a much higher grade of workmanship than for package freight.

In addition to the particular requirements of the owners, it will also be specified that the ship is to be built to the requirements of either Lloyd's, The American Bureau of Shipping, or some other recognized classification society, and the surveyors of the chosen society will see to it that its requirements are lived up to. It may be pointed out in passing that the rules of the various societies specify, to the thirty-second of an inch, the size and thickness of all members entering into the structure of the ship, as well as the size and type of all fastenings; their rules being based primarily upon the theoretical strains experienced by ships subjected to the action of deep-sea waves, but modified by scores of years of experience covered by comprehensive reports of hundreds of catastrophes at sea, these reports being made by surveyors of the societies who are themselves seafaring men and who have carefully investigated the probable causes, and possible preventive measures, in each particular case.

Let us now assume that all the particulars of the ship to be built have been decided upon, the contract plans completed and the contract signed, and place ourselves in the position of the successful bidder. We find that we have on our hands a contract to furnish all material to construct, launch, power and equip a ship of, for example, 5000 tons deadweight, which is 350 ft. in length by 48 ft. in width by 28 ft. in depth, and has engines of 1500 to 2000 i.hp.

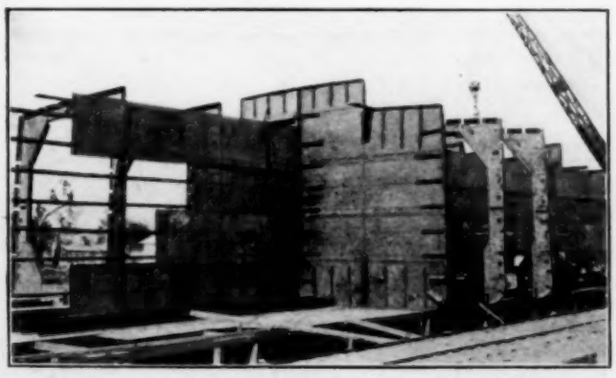
Perhaps, under present conditions, we have not done much more than select our site for building. If this has been done, it goes without saying that a frontage was chosen on as deep and wide a waterway as was compatible with financial and engineering considerations, and also that the site selected is reasonably accessible to a labor market.

The next step is to lay out our building ways to suit the water into which we propose to launch. We have now a choice of two methods of launching, i.e., stern first, or sideways. The stern-first method is universal at all Atlantic Coast yards and wherever the required width and depth of water is obtainable. The side launching is largely confined to the yards on the Great Lakes and to other plants where for various reasons it is found desirable to build on the banks of a narrow waterway.

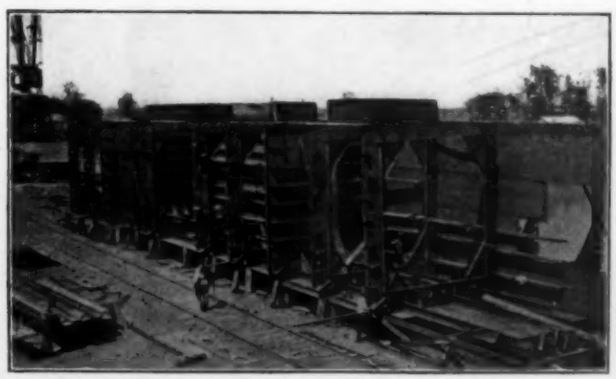
For the stern-first method the following conditions will govern: The building ways will be so located that the stern of the vessel will be close to the water's edge and 3 to 4 ft.

[1] Engineer, Mexican Petroleum Corporation, New Orleans, La.

Presented at a joint meeting of the Louisiana Engineering Society and the New Orleans Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, September 7, 1917.



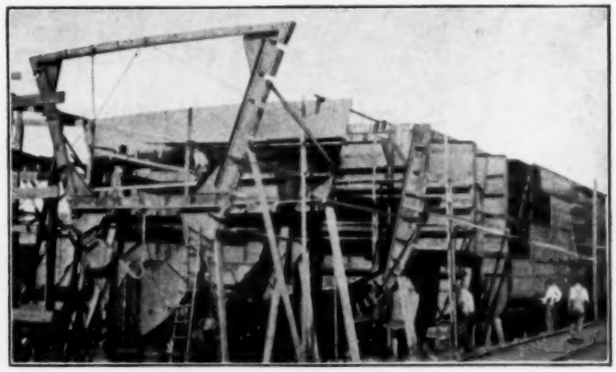
Hull 23, March 31, 1917.



Hull 23, April 6, 1917

VIEWS SHOWING PROGRESS OF STEEL SHIP CONSTRUCTION AT VIOLET, LA.

Hull 23, May 9, 1917



Hull 23. Bow, September 14, 1917

STEEL SHIP CONSTRUCTION AT VIOLET, LA.

above the ground. From this point back they will be given a rise of about five-eighths of an inch per foot, which would put the keel line at the bow of a 350-ft. ship some 21 ft. above water. A yard having a natural easy slope toward the water is therefore desirable as facilitating the construction of the underbody of the ship without the necessity of filling to the desired grade. The building ways consist of a series of blocks spaced about 4 ft. center to center and made up of 12 by 12-in. timbers 5 or 6 ft. long, set transversely and resting on piling.

The launching ways consist of two parts, the standing and the sliding ways, and are parallel to the center line of the ship and about one-third to one-half the half-breadth from it. They are constructed of heavy longitudinal timbers laid on piling and are usually given a camber or round-up of about a foot in their length for the purpose of overcoming the resistance of the water as the vessel nears the end of the ways.

A customary slope is about ½ in. per ft. at the bow of the ship, increasing to ¾ in. per ft. at the submerged end of the ways. This lower end should be 5 or 6 ft. below the surface and should be well supported by clusters of piles as, at the moment before the bow drops off the end, nearly half the weight of the ship bears on this point. The construction outlined is the common practice in tidewater yards and the datum plane taken is that of high tide.

It will at once be seen that we meet insurmountable obstacles when we propose to adapt this method to a river such as the Mississippi, where a variation occurs of twenty or more feet, and this so gradually that months may elapse between two successive periods of high water. If, for example, it has been planned to launch at high water and completion has been delayed for four or five months beyond the schedule, the builder is confronted with the alternatives of waiting for the next high water or flattening the launching ways and extending them some 400 ft. further, a procedure which would not appeal to the yard superintendent very favorably.

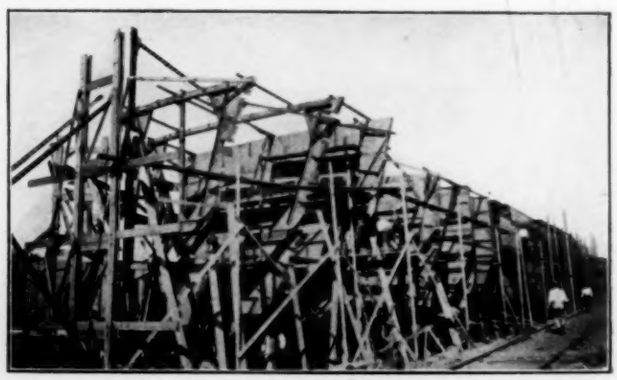
It has been suggested that ships could be built behind the levee, or in a sort of semi-dry-dock with gates, the grade being established midway between high and low water. A little consideration will show the impracticability of this scheme, for both high- and low-water conditions must be met. A levee must surround the building ways in case launching is to be at high water, and for low water nearly the same impractical length of ways would be required, as has been already described.

So far, then, as building on the Mississippi is concerned, it is believed to have been shown that the only practical location is upon a locked canal, and this, of course, involves a side launching. With this method, the keel is laid parallel to the bank, and instead of two sets of ways there are perhaps a dozen or more at right angles to the keel. The construction of the ways is similar to those already described, except that they may either be carried below the water surface (in which case the final camber is much greater than the longitudinal ways) or they may be stopped off short above the surface and the vessel "dumped" off. In either case the launching is a much more delicate proposition than the stern-first method, as all the ways must be released at precisely the same instant, any variance carrying the practical certainty of disaster.

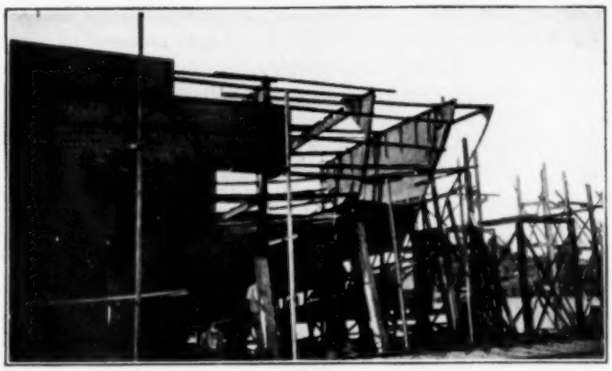
With either type of ways the maximum loading per square foot of sliding surface should not exceed 2½ tons, especially in warm weather, as heavier loading forces out the grease and chars the ways.

The next most important step is the ordering of the structural material, and this is done by the builder's superintendent from the contract plans, which consist of midship section, inboard profile, deck plans, bulkheads, and (if the vessel is to be of steel) the plating model. The latter is accurately made from the line drawing and on it are shown the exact sizes and thicknesses of all shell plates, as well as data concerning seam and butt riveting, doubling plates, longitudinals and transverse frames. All plates are ordered to within ½ in. of the desired size and are so shipped by the mills. Every plate, channel, or angle is inspected and tested at the mill by the surveyor of the registration society and a permanent record made of its characteristics as well as its location in the finished vessel.

In the interval preceding the delivery of the material the loftsman is busy with his force laying down to full size and fairing the lines of the ship on the mold-loft floor. These



HULL 23, SEPTEMBER 29, 1917



Hull 23, October 1, 1917

Hull 23, December 4, 1917

Steel Ship Construction at Violet, La.

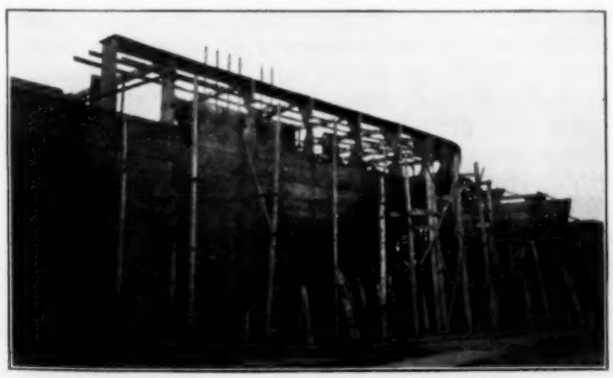
lines are the intersections of vertical transverse, vertical longitudinal, and horizontal planes with the outside shell of the ship, and the three views must be made to agree precisely or the resulting surface will be unfair. In some yards the lines are first drawn and faired to a quarter-inch scale in the drawing room, the offsets or ordinates from this set then laid down and refaired to a one-inch scale on a marble slab, and finally the offsets from the slab laid down and faired to full size on the mold-loft floor.

Methods have been evolved for deriving mathematically the lines of a ship of given characteristics, but as the simplest of these methods involves the use of formulæ with five variables they have not become altogether popular.

From the lines as drawn are now derived the exact contour of each transverse frame, as well as its bevel, the location of plating seams, and the traces of longitudinals and decks.

Templates of thin white pine are made of the frames and on these is shown all the information necessary to enable the shop to fabricate them. These templates then go to the bending floor, and the frames when bent and beveled go to the punch shop and are finally set upon the blocks and tied to the center keel and keelson plates which have preceded them. With the frames secured in place with longitudinals and temporary rib bands, templates are made from the skeleton for each shell plate and these templates applied to their plates which have now arrived from the mills. If the ship is known as a "full" ship and has a considerable percentage of parallel middle body, much of this work may be done in the loft and one template be made to answer for a dozen or more plates.

By intelligently applying the above principle to the original design a great amount of unnecessary labor may be eliminated, not only in the shell, but on bulkheads and decks as well.



Hull 23, Stern, November 29, 1917

The advantages above outlined would not, of course, apply in the same degree to the construction of a wooden vessel, as in this case once the frame templates are out it is largely a case of cut and fit for each timber and plank.

It is only reasonable to believe that by a judicious duplication of parts, by adhering as far as possible in a given yard to a given size and type of ship (as is now done in England), by reducing the number of plates which must be "lifted" from the ship itself, and by the introduction of efficient cost-keeping methods we will be able, when the present abnormal conditions have passed, not only to hold our own but actually to take the lead in this industry.

Turning for a moment to the power-plant side of the question, the builder and owner are faced by the necessity of deciding upon exactly the kind of plant desired. Let it be assumed that the indicated horsepower and speed have been determined. The combination of the two will give within reasonable limits the revolutions per minute of the propeller or propellers. There is then the choice of twin or single screws, with either compound or triple-expansion steam engines, turbines with gear reduction, Diesel engines or a turbo-electric system. In the particular case of four rather small vessels now building in the vicinity of New Orleans the advantage was found to lie with the latter system in price, weight and delivery, and that system was therefore adopted.

It is believed that there are very few, if any, shipbuilders in this part of the country who are at present equipped to economically construct marine engines, though it is hoped the opportunity will be afforded by the United States Shipping Board for local shops to become accustomed to this type of work so that they may intelligently and profitably undertake merchant work when the present shipping crisis has passed.

With regard to boilers, there are a number of shops in the immediate vicinity which are entirely competent to undertake the construction of fire-tube marine boilers to meet any requirements. As to type, the only fire-tube boiler in common marine use is the Scotch or wet-back type, in which the combustion chamber is integral with the boiler and is surrounded by water.

Of the water-tube type there are many makes, such as the Babcock and Wilcox, Heine, Sterling, Yarrow, Ward, etc., all of which are manufactured in both land and marine styles.

In direct connection with the choice of engine and boiler arises the question of whether or not it is desirable to superheat the steam, and if so, what type of superheater should be

adopted. With many of the water-tube boilers the superheaters are integral; that is to say, are really an extension of the tube surface. With the Scotch boiler, however, they are usually independent and are placed in the breeching.

In addition to the main power plant there will be required a main condenser with air and circulating pumps, boiler-feed pumps, fire pumps, anchor windlass, steam capstans, refrigerating plants, winches, and possibly a towing engine, as well as evaporators and distillers. These auxiliaries are fairly well standardized, and the purchaser is practically sure of getting what he pays for.

For the valves, pipe and fittings, of which there are thousands of dollars' worth on a ship of any size, some of our local houses are willing to exert themselves to the extent of quoting from a set of piping plans, with bill of material attached. Others prefer apparently not to do so when there is enough business coming their way without any effort on their part.

Having disposed in our allotted few brief words of yard, hull, and power plant, we have nothing left to think of but the arrangement of living quarters, carpenter work, joiner work, ladders and gratings, rigging, plumbing, ventilation, galley and linen stores, boatswain's stores, life boats and davits, carpenter's stores, fire-extinguishing apparatus, running lights, cooking and mess equipment, engine-room telegraphs, bilge and ballast system, and if we are so fortunate or unfortunate as to be building oil tankers, the entire cargo-handling system!

From the local builder's point of view there is one question which eclipses even the difficulty of securing delivery of materials under present conditions, and that is the problem of obtaining, in competition with the large northern yards, labor skilled in the art of shipbuilding. The ship carpenter of the days of the old wooden clipper ships, of whom was written, "Build me strong, O worthy master," is almost as extinct as the dodo bird, while ship fitters, ship smiths, loftsmen and other skilled workers are demanding and receiving wages that would have seemed affluence five years ago. At least one local yard (of which the writer has personal knowledge) is doing remarkable work in the training of colored labor for all except the most responsible positions in these trades, and is achieving excellent results in quality of workmanship.

To summarize briefly, it would appear that success of the southern shipbuilder rests on the following points:

1 Judicious selection of site
2 Rational layout of yard, with due regard to receiving, handling, storing, and routing of material
3 Foresight in design, with a view to standardization of all possible parts and the elimination of special and the use of stock fittings which may be purchased in the open market
4 An efficient cost-keeping system
5 The training of the labor which is locally obtainable and may reasonably be counted upon to remain
6 Promotion of a knowledge of the principles of shipbuilding by the establishment of classes in the public night schools.

[The paper was illustrated by lantern slides and was followed by discussion, in which several members of the Louisiana Engineering Society and of the A.S.M.E. took part.]

THE DEVELOPMENT OF CONCRETE BARGE AND SHIP CONSTRUCTION

By J. E. FREEMAN[1], CHICAGO, ILL.

THE need of ships has become increasingly evident to all, and that their construction in large numbers is a vital part of our war program is thoroughly understood. Judge George Gray, of Wilmington, Del., a member of the War Shipping Committee of the Chamber of Commerce of the United States, said recently in a plea addressed to the shipbuilders of the country: "There is no exaggeration in the statement that the necessity for an adequate production of ships is the most serious matter that now confronts us in this the greatest crisis in our country's history, or in the history of the world. We have entered this war for a just cause, and we must prosecute it with all our might and with all the resources of our country. Otherwise we cannot win it."

But speed is essential in securing tonnage, not only to replace submarine sinkings but to provide the great fleet of vessels to transport and maintain an adequate army in the field and still continue to keep our allies supplied with certain necessities. We need this fleet in the quickest possible time. "Make a bridge of ships to France" is the latest message from General Pershing and his men.

The tonnage of steel and wooden vessels now under construction in countless yards, to which are added ships transferred from coastwise and Great Lakes service, is still short of what is needed. To solve the problem requires the rapid development of all methods of shipbuilding, and it is for this purpose that reinforced concrete is now being considered and utilized to augment the tonnage under construction. The first seagoing vessel of concrete has made successful trial trips and vessels of larger tonnage are under construction both here and abroad.

The concrete-ship construction now under way in this country is of course largely experimental, assisted by experience gained in the design of steel and wooden ships; but there is every indication of ultimate success, and, as has been the case in other applications of concrete to new uses, experience with these first vessels will provide data to improve and clarify present ideas and to develop efficient methods of design and construction. Those who have thus far worked out designs for concrete ships have done so more or less independently, and up to the present time only meager information has been published regarding the data and calculations upon which their designs are based. But recent advices show that the Government is studying the problem, that a Department of Concrete Ship Construction has been formed by the Shipping Board, which is actively engaged in the development of a standard design for a concrete cargo ship of 3500 tons capacity, and drawings and specifications are expected to be ready in March. Provisional contracts have also been let to three companies for a number of 3500-ton vessels, plans and specifications for which must be approved by the Shipping Board. This has already been described in the technical press.

This present discussion of concrete ships and barges therefore must of necessity be rather general, presenting a brief review of progress in concrete-boat building from its earliest

[1] Portland Cement Association.

Abstract of paper presented at a meeting of the Engineering Society of Buffalo, February 13, 1918.

inception, describing some of the interesting work under way at the present time, and calling attention to the various problems entering into the application of reinforced concrete to such construction.

Singularly enough, boat building furnished one of the first uses of what would today be called reinforced concrete—a rowboat was built of this material in 1849, by M. Lambot, of Carces, France. This instance thus marked the starting point not only of concrete-boat building, but also of modern reinforced-concrete construction. This boat created considerable interest when exhibited by its builder at the World's Fair in Paris in 1855, and it was still apparently in excellent condition as late as 1903. Records are lacking, however, of any further development in France, until 1900, when a gravel barge 50 ft. long, 13 ft. wide and 3 ft. deep was built on the River Lozere.

In 1899 Carlo Gabellini, of Rome, began the construction of concrete barges and scows in Italy, and in 1905 a 150-ton barge was constructed for the city of Civita Vecchia. Later another barge was built for the use of the Italian Navy at Spezia; before acceptance, this barge was put to the severe test of being driven against piling and afterward being rammed by a steel tugboat. Up to 1912 about eighty vessels had been constructed by the Gabellini concern.

Beginning as early as 1887 small concrete barges of 11 tons capacity were built successfully by the Fabrieck van Cement-Ijzer Werken, in Holland, followed later by larger craft of 55 tons capacity with a cellular construction formed by longitudinal and transverse partitions or bulkheads and reported as making the boat practically unsinkable.

In Germany a 220-ton concrete freighter was built in 1909. The major portion of the hull had parallel sides, but was so shaped that the lines were fairly good and the water resistance was decreased below that of a rectangular barge. This vessel also had watertight bulkheads. It is reported that since 1914 Germany has built numerous concrete barges and some concrete ships.

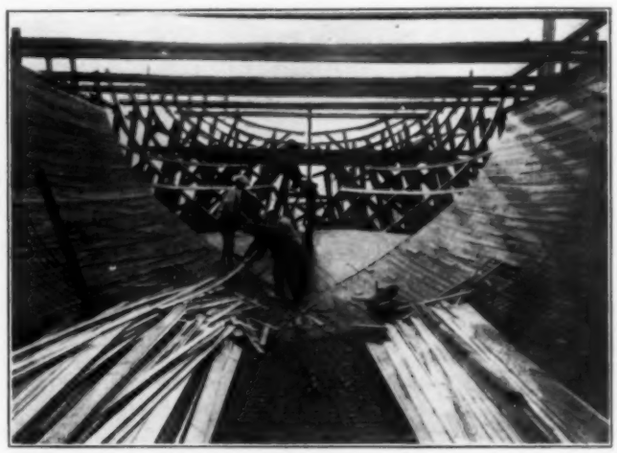
In 1912 a reinforced-concrete scow or pontoon was built by the Yorkshire Hennebique Contracting Co., Ltd., of Leeds, England, for maintenance work on the Manchester Ship Canal, in accordance with the requirements of the canal company's engineers. The craft is 100 ft. by 28 ft. by. 8 ft. 6 in. deep from main deck to keel, drawing about 6 ft. 6 in. when loaded to capacity (about 224 tons). It carries centrifugal pumps, steam winches, engines, boiler and coal supply. The hull consists of a series of watertight compartments, so designed that if the exterior shell were destroyed the body of the hull would still remain afloat. The compartment containing the boiler plant has a 4-in. floor and heavy beams supporting coal bunkers and boiler, but otherwise the general construction is light; the outer skin of the hull is only 3 in. thick. All watertight compartments were carefully tested by filling them with water. The scow has been in almost constant service since construction with small expense for repairs.

In 1910 the building of concrete barges was undertaken on this side of the Atlantic. On the Welland Canal an 80-ft. barge of 200 tons capacity, called the *Pioneer*, was built for maintenance work. Design and construction were carried out under the supervision of J. L. Weller, St. Catharines, Ont., engineer in charge of the canal work. The barge has a beam of 24 ft. and depth of 7 ft., with rounded bow and a square stern. The hull was divided into eight compartments by longitudinal and cross bulkheads, double hatchways at stern and openings through the cross bulkheads giving access to all parts. The deck, bottom, sides and bulkheads are 2½ in. thick, reinforced in two directions with ¼-in. steel wire and strengthened by the bulkheads and by beams and posts of reinforced concrete about 6 by 8 in. in size. Two 6 by 8-in. oak timbers serve as fenders. The barge draws 2 ft. 8 in. light (130 tons displacement), and when loaded to capacity has a draft of 6 ft.

This barge has been in almost constant service since construction with practically no maintenance charges and is still in excellent condition. At times she has been loaded with 10-ton carloads of rubble stone dumped from a height of 12 to 15 ft. directly on to the 2½ in. deck, the full load starting at one end.

On the Panama Canal three concrete barges 64 ft. long, 24 ft. beam and 5 ft. 8 in. deep were built in 1910 to carry dredging pumps, forming part of a plant used for hydraulic excavation at the site of the Miraflores locks. They were launched in the spring and summer of that year. Reinforced concrete was used because it was impossible to obtain skilled labor and suitable material for the construction of steel or wood barges within the time required. The walls and bottom were made 2½ in. thick—two 3-in. bulkheads extending from bow to stern, making three compartments. Longitudinal beams at top and bottom of bulkheads and side walls, with posts at 10 ft. intervals, cross-connected at posts by beams with knee braces, comprised the general framing plan. The shell was a 1:2 mortar plastered on the steel skeleton of rods and mesh. Interior

Center to Stern of Reinforced-Concrete Boat Under Construction at Redwood City, Cal.



Construction of Concrete Cargo Steamer at Barcelona, Spain

members were 1:2:4 concrete cast in forms. The draft was 3 ft. 5 in. with a total load of about 140 tons.

Following this work, in 1913 and 1916 a number of reinforced-concrete pontoons were built at Panama to serve as landing stages for boats up to 65 ft. in length, and have been in regular use since. These pontoons are 120 ft. long, 28 ft. wide and 8 ft. deep.

Oscar F. Lackey, when harbor engineer of Baltimore, developed a system of construction which was first used in 1909 to build a landing stage for small boats, and then in 1912

LAUNCHING A 200-TON CONCRETE LIGHTER AT PORSGRUND, NORWAY, JULY, 1917

was applied to building a 500-ton concrete gravel scow for the Arundel Sand and Gravel Company of that city.

This latter craft has a length of 113 ft., a breadth of 29 ft. and a depth of 10 ft. 6 in. Four longitudinal bulkheads and five cross bulkheads divide it into twenty watertight compartments. The shell and deck are supported by a series of vertical and horizontal beams, the slabs varying from 3 in. to 5 in. in thickness, reinforced with plain bars running in both directions. The hull was built between forms and a very rich concrete mixture was used, with coarse aggregate of about ½-in. maximum size. With the intention of facilitating towing, the sides were rounded on about a 6-ft. radius and worked into sloping ends which were carried back much further than in the ordinary scow. Light, the scow draws 4 ft. 3 in., and when loaded to its capacity has 1 ft. freeboard.

This scow has been in daily use ever since construction, is perfectly watertight and has withstood the roughest kind of handling. It has required no pumping out.

The full-rounded sides and ends developed some undesirable features under load in a high sea or strong wind and in berthing. Consequently, in two other scows that were built in 1913 and 1915, respectively, a design more along the lines of the ordinary wood scow was utilized. These later scows were also cheaper to construct, form work being less expensive and placing of reinforcement easier. In the second of these scows five longitudinal and five cross bulkheads were used, and a combination of bars and expanded metal used for reinforcement. In the third scow an intermediate deck was introduced. The difficulties found in towing the first scow were eliminated and the draft reduced to 3 ft. 10 in. This was slightly in excess of a timber scow of the same capacity, but the concrete scow towed as easily when new, according to Mr. Lackey, and more easily than the other after a few months' service because of the lack of formation on the bottom.

One of these scows is used by the Raymond Concrete Pile Co., at Baltimore, a letter from which company last July stated that it had been very satisfactory in every respect and there had not been a dollar's worth of repairs since the scow was placed in commission.

Considering that these scows are watertight, do not require scraping, calking or painting, or maintenance other than repairs to the wooden-fender system, and crediting the cost of time that would otherwise be lost in making such repairs, the concrete scow becomes a decidedly interesting proposition.

England and France have recognized the utility of barges and self-propelled lighters of concrete. Last spring an English periodical mentioned a French company formed for the purpose of building seagoing concrete lighters; later pictures were shown of concrete boats under construction on the Paris Ship Canal. The Under Secretary for Sea Transportation and Merchant Marine in France was recently quoted as saying that very interesting experiments had been made with two concrete lighters in service. This has doubtless led to the building of more craft near Bordeaux, also several twin-screw vessels at Ivry-on-Seine, recent press photographs of which give a general idea though details are lacking. An English paper reports orders on hand from the French Government for several hundred concrete barges. Several English firms have begun the building of motor-driven barges of concrete, and more recently a concrete shipbuilding company has arranged for a yard at Dundee, Scotland.

James Pollock & Sons Company, a London firm of naval

LAUNCHING A 200-TON CONCRETE LIGHTER AT PORSGRUND, NORWAY, JULY, 1917

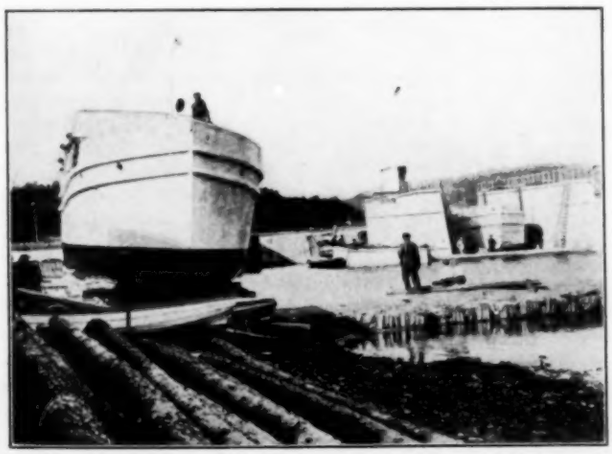
architects and engineers, has drawn plans for a fleet of small coasting vessels of reinforced concrete, the first vessel laid down having a length of 92 ft., beam 19 ft. and depth 10 ft. Power is obtained from a 120-hp. oil motor. In coasting vessels which need not make over 8 miles per hour, the use of straight lines would not necessarily be a handicap, and these concrete vessels have therefore been designed with such lines wherever possible to reduce form work, simplify bending, placing of reinforcement, etc. This firm is now drawing plans for larger vessels of 500 to 1500 tons cargo capacity.

A letter just received from a former Chicago engineer, now in England, advises that he has recently designed a number of barges and seagoing vessels of reinforced concrete and is at present interested in the building of ten such seagoing barges of 1000 tons capacity. A recent statement by the First

Lord of the Admiralty that ferro-concrete barges up to 1000 tons were being built in Great Britain possibly refers to this same work.

A Spanish reinforced-concrete cargo boat will be launched shortly by a corporation known as Works and Pavements, of Barcelona, the first firm in Spain to engage in the construction of concrete ships. The length of the first vessel is about 110 ft., beam 23 ft. and depth 11½ ft. Power will be supplied by a 120-hp. Diesel engine, and in addition sails will be fitted to the vessel. The company plans to construct during 1918 a gross tonnage of 40,000 in standard ships of 300, 500 and 1000 tons each, while ground has been acquired to permit later the construction of thirty boats at a time, some of which are planned to be of 6000 tons capacity. This company uses a mixture of 650 kg. of cement to 1 cu. m. (1:2½) of inert materials (gravel and sand of three sizes) so as to obtain, in its own words, "a dense, impermeable mixture that will permit also constructing the thinnest permissible section with a view to reducing maximum weight and thus obtaining the greatest possibilities in the way of speed." The concrete is considered to develop a compressive strength of 271 kg. per sq. cm. (approximately 3800 lb. per sq. in.) in 90 days, and a working strength of 76 kg. (approximately 1100 lb. per sq. in.) has been adopted.

Yet this work in shipbuilding is not entirely new, for Norwegian and Danish firms have already built and launched several concrete ships and self-propelled lighters of 200 tons capacity and now have larger craft under construction. The Fougner Steel-concrete Shipbuilding Company, one of the first in the field, has a plant at Moss, established in 1916. Following successful experiments made by Mr. Nic. K. Fougner with a 50-ton concrete lighter at Manila in 1914, the company has built some eighteen or twenty reinforced-concrete lighters and tow boats. These lighters have capacities of 100 to 200 tons, the later types having more the barge shape. Some are in use along the Norwegian coast and others have been bought by the Norwegian Navy. A loading test recently reported of a 64-ft. 100-ton lighter over an unsupported length of 40 ft. showed a deflection of about 0.6 in. under a uniform load of 16 tons, in addition to the weight of the lighter itself which was 58 tons. The surface is reported to have shown no sign of cracking or indications of flaws.



LAUNCHING THE 200-TON SEAGOING CONCRETE MOTORSHIP *Namsenfjord* AT MOSS, NORWAY, JULY, 1917. CONCRETE FLOATING DRYDOCK IN BACKGROUND

The structure consisted mainly of keelson and ribs of reinforced concrete with a thin shell of concrete plastered on expanded metal or cast around rods, and this method of construction has been applied to the first sea-going concrete ship, the *Namsenfjord*. This vessel was launched last summer, was given a high rating by Lloyd's and is now in service for coastwise traffic. The vessel has a cargo capacity of 200 tons on 9½-ft. draft and is driven by a Bolinder crude-oil engine of 80 hp. at a speed of about 7½ knots. The length is 84 ft., beam 24 ft., molded depth 11½ ft. Larger ships of 600 to 1600 tons are now building, but their general design is much the same as that of the *Namsenfjord*, briefly described as follows:

There is a keelson of reinforced concrete with cross frames every 4 ft., the frames being continuous along sides and bottom and tied to the keel by the rod reinforcing. Particular attention is paid to continuity of reinforcement for these frames, and knee braces are provided at corners of the hull. The skin is 3 in. thick, reinforced with mesh and having a longitudinal beam at the outer corners of the hull. Concrete-filled pipes are used for center posts at intervals. The hull is divided into watertight compartments by transverse bulkheads of concrete reinforced with metal lath. The cabin is of wood and wood fenders are provided.

In building the hull, the bottom is cast in forms up to the top of the longitudinal hull beam previously mentioned. For the side of this size vessel the reinforcement and metal lath is set up for the total height and concrete deposited between the two sets of lath which act as a form; the outside and inside surfaces are then plastered. For larger boats this procedure is altered, using shorter heights of lath or casting the main frames in forms. Care is taken to make the construction continuous however, so that no joints are left in surfaces exposed to water.

In the earlier craft 1:1½:2 or 1:1½:2½ concrete was used with ½-in. maximum size aggregates, but later developments showed a 1:2 mixture with ¼-in. material worked better around the reinforcement.

The company has a contract for a 4000-ton ore carrier 254 by 40 by 19½ ft., equipped with two 300-hp. Diesel engines, and only awaits authorization by the Norwegian Marine Registry before proceeding with the construction. It has also constructed for a Christiania firm of yacht builders a floating drydock of concrete—the first of its kind—with a lifting capacity of about 100 tons, which suggests another field for development in the present emergency. The dock is 80 ft. long, 38 ft. wide and 20 ft. high, with a sill 4½ ft. thick and side walls 6½ ft. wide at the bottom. There are nine watertight compartments. The dock accommodates a vessel 75 ft. by 25 ft. and is equipped with an electrically operated centrifugal pump by means of which a 100-ton load can be lifted from the water in one hour. The Fougner Company is reported to have plans for larger docks up to 15,000 tons capacity.

The ships built according to the Fougner system have a ratio of dead weight to displacement from 12 to 15 per cent less than for steel ships, that is, their displacement is more for the same cargo-carrying capacity. [By dead weight is meant the cargo-carrying capacity expressed in tons, usually in terms of long tons (2240 lb). The displacement of a ship is the weight of water she displaces, and covers the weight of the ship itself plus the dead weight.]

The Fougner Company has established an American branch in New York, and is reported to have a contract with the Shipping Board for several 3500-ton ships contingent upon the success of the first vessel. It is stated that the Ferro-Concrete Shipbuilding Corporation, of New York, and the Liberty Shipbuilding Company, of Boston, also have similar contracts.

Another Norwegian company actively engaged in concrete-boat building is the Porsgrund Cement Construction Works, at Porsgrund. After the construction of a bridge pontoon in 1913, experiments were begun with a view to simplifying the form work and construction methods, as a result of which it was determined to build the boats upside down and launch them in that position. Following successful experiments with a 9-ft. model, a 200-ton barge was built and launched last summer. The barge has a length of 98½ ft., beam 19½ ft. and molded depth of from 9 ft. at center to about 10½ ft. at bow and stern. It will be equipped with a 70-hp. motor. Other lighters are in process of construction having capacities of 600 to 1000 tons. The general design follows that of a framed steel ship. The righting of the boat took about 20 minutes, an ingenious arrangement of inner airtight compartments making the craft practically self-righting.

The principle may be briefly described as follows: The inner mold is divided into compartments; when the vessel enters the water the air gradually escapes from the middle and upper two compartments through vent pipes, and the vessel losing buoyancy gradually sinks to a point of maximum submergence. The lower side compartments never being flooded, the vessel is in a state of unstable equilibrium, the center of gravity being considerably higher than the center of buoyancy. If the vessel now heels slightly to one side or the other, a couple is formed, the moment of which tends to turn the vessel on a longitudinal axis until the vessel is righted and floats in correct position. The flooded compartments are then pumped out and the molds removed to be used again for a similar vessel.

Progress in concrete shipbuilding has been made in Denmark also: one firm is reported to have several types from 300 to 1000 tons dead weight approved and classified by the Bureau Veritas for overseas service. The work has even developed so far that official rules have been laid down for design applying to the construction of flat-bottomed vessels of reinforced concrete.

At Montreal, Canada, the construction of a 126-ft. ship of about 350 tons capacity was started early in September, 1917, by the Atlas Construction Company, Ltd., and the vessel launched in November. This ship has a beam of 22½ ft. and a depth of 12½ ft. The ribs are of structural steel encased in concrete and spaced about 27 in. apart, the steel sections being 5 in. deep at the top and 14 in. at the base. Before the plans were prepared by C. M. Morssen, president of the company, and Prof. Ernest Brown, of McGill University, tests on model ship beams were made to ascertain the resistance of concrete to some of the strains encountered in ship design. The shell is of reinforced concrete varying from 3½ to 5 in. in thickness, approximately 50 tons of reinforcing steel being used in construction. The concrete is reported to be practically a mortar, about 1:1½:1, with small gravel. It was placed between forms, construction being carried on as continuously as possible. The vessel is of the single-screw type capable of about 8 knots.

The concrete vessel to which probably the greatest interest attaches at present is a 336-ft. single-screw cargo steamship of about 5000 tons capacity being built at Redwood City, near San Francisco, by the San Francisco Shipbuilding Company. The ship has a beam of 44½ ft. and a molded depth of 30 ft., with a designed load draft of 24 ft. She is to be fitted with Scotch boilers and triple-expansion engines of 1750 hp., giving a speed of 10 knots. Fuel-oil tankage is provided sufficient for 30 days' steaming.

The hull is divided into nine watertight compartments by concrete bulkheads. The frames or ribs of the hull are spaced about 4 ft. apart and there are also interior columns for the support of the two decks. The shell is reported to be about 5 in. thick at the bottom, decreasing to 4 in. at the deck, which is about 3½ in. thick. In addition to the diagonal-rod reinforcement in the shell, wire fabric is placed ¾ in. from the outside surface.

According to recent reports concrete is now being deposited in the forms, using a 1:1½:2 mixture with ¾-in. maximum size coarse aggregate and carefully graded sand. During the placing of the concrete the outsides of the forms are hammered to thoroughly consolidate the concrete and produce a dense surface. After stripping the forms the hull is to be sand-blasted and given a coating of gunite, later finished by rubbing.[1]

Although several firms in New York City have been developing plans for barges, the first construction work of this character was begun by the Louis L. Brown Company last October on a 700-ton deck scow of length 112 ft., beam 33 ft., depth 10 ft. and light draft 3 ft. 4 in.

The frame of the barge consists of reinforced-concrete members supporting a thin concrete shell reinforced with wire mesh. Rail, bulkheads, and deckhouse are of concrete; wooden fenders will be used. Concrete is placed by means of a cement gun.

Construction of a 500-ton scow will be started shortly at Vancouver, B. C., the plans having been prepared by the Taylor Engineering Company, of that city. This has an overall length of 107 ft., beam 32 ft., and depth 9½ ft. It will draw 3½ ft. light and 8½ ft. when loaded to capacity. The truss method of framing is of interest. The same company is now designing a 1200-ton well-deck scow. A New Orleans sand and gravel company is now building a deck barge 130 by 30 by 7½ ft. deep, of about 550 tons dead weight.

A joint committee of the American Concrete Institute and the Portland Cement Association has been investigating this subject in a preliminary way. It recently prepared a report covering points to be considered in designing concrete vessels and submitted a tentative design for a 2000-ton seagoing barge of the following dimensions:

Length	227 ft. 6 in.
Length between perpendiculars	220 ft. 0 in.
Beam	42 ft. 0 in.
Depth	23 ft. 0 in.
Loaded draft	18 ft. 0 in.

The displacement was estimated to be 3675 tons or an 18-ft. draft. The vessel is divided into five compartments by transverse bulkheads, the three center compartments being for cargo and the other two for tank and ballast.

In designing, the criterion followed was a steel ship designed according to Lloyd's rules, and practically equivalent strength provided in reinforced concrete. A concrete of 1:1:2 mixture with carefully selected sand and selected gravel (about ½-in. size) was decided upon and considered to develop an ultimate crushing strength of at least 3000 lb. per sq. in., allowing a maximum stress in concrete of 1000 lb. per sq. in.

The spacing of the frames is 4 ft. and the thickness of shell 4 in. on the sides and 5 in. on the bottom. Two lines of reinforcement are provided. The deck is 3 in. between hatches and along the lines of the hatches and 5 in. thick outside these lines.

[1] Since this was written, word has been received that the hull has been completed and the vessel successfully launched.

An estimate of quantities gave the following:

Concrete	731 cu. yd.
Steel	482,000 lb.
Flooring for hold	30,000 ft. B.M.
Oak timber (fender rail, etc.)	15,000 ft. B.M.

The total weight of the ship was estimated to be 1647 tons and the carrying capacity 2028 tons for 18-ft. draft. The cost of the hull per ton dead weight was estimated at $63; the best available figures indicated a cost of steel hull of the same character of $90 to $120 per ton and up; cost of wooden hull of $70 to $100.

A few paragraphs from the report of the joint committee are given below and may be of interest in regard to points connected with the design and construction of concrete vessels.

"It is apparent that the efficiency of a ship as a cargo carrier depends upon the relationship between dead weight and displacement. Expressed in terms of per cent, in the average cargo ship built of steel, the dead weight is from 70 to 75 per cent of the displacement—taking into account as weight of ship all spars, fittings, deck houses, anchors and chains, auxiliary engines and tanks, but not boilers, engines or coal. In a wooden ship, the dead weight is from 60 to 65 per cent of the displacement. It is quite evident that from the difference in weight of materials, it will be difficult to design a ship of concrete that will give a relationship between dead weight and displacement approaching that of steel. However, if ships are to be built of concrete for commercial use, the weight of the ship must be such as to provide a reasonable dead weight or cargo capacity for the displacement.

"The stresses in the transverse members of a ship are, in still water, functions of the draft and the stiffness, and may be computed by mathematical processes, although the computations are long and laborious. When the material is reinforced concrete the problem becomes much more complicated. Experience has shown, however, that numerous elements other than draft affect the transverse strength of a ship, such as the effect of rolling in a sea way, impact with docks or other ships, and stresses incident to going into drydock. The transverse members of cargo ships of today are, therefore, not designed to withstand computed stresses, but are designed in accordance with various rules which embody the result of long experience in the construction and use of ships. It should be noted in this connection that granting of insurance depends on compliance with these rules."

"Steel ships are of two different types, (*a*) framed ships, in which transverse ribs or frames are spaced from 18 to 24 in. on centers, the plating being riveted to these ribs without intermediate longitudinal members, excepting in the bottom; and (*b*) longitudinally framed ships (Isherwood), in which heavy frames are spaced from 10 to 15 ft. on centers, with intermediate longitudinals to which the plating is riveted."

"From a comparison with the ordinary steel-ship design, it would appear to be not difficult to design transverse members of reinforced concrete of equivalent strength to steel members—the question of strength only being considered."

"A ship must be able to meet conditions which are unlike any to which land structures are subject.

"In determining the longitudinal strength of a ship, it is customary to assume two conditions. Under the first condition, the ship is assumed to be suspended between two wave crests, the length between crests being equal to the length of the ship between perpendiculars, the height of the wave being equal to one-twentieth of that length. In this case, the ship as a whole is acting as a simple beam supported at the ends. This condition is termed 'sagging.' Under the second condition, the ship is assumed to be supported amidships on one crest of the same wave. Under this condition, the ship as a whole acts as a cantilever. This condition is termed 'hogging.' It is apparent, therefore, that when a ship is riding the waves both the deck and the bottom of the ship will be required to withstand tensile and compressive stresses alternately—the maximum tensile stress following the maximum compressive stress at very short intervals. In a steel ship the entire cross-sectional area of the midship section acts to resist these stresses, taking into account, in determining the moment of inertia, all of the continuous members, such as continuous scantlings and deck, side and bottom plates. In the concrete ship equivalent strength must be provided. In the case of the concrete ship, however, only the steel reinforcement can be relied upon to take tensile stresses. The concrete, assisted by the steel, will take the compressive stresses."

"There is an almost unanimous opinion among naval architects and seafaring men generally that a concrete ship will be so inelastic that she will tear herself to pieces in a sea. While it is doubtless true that in a concrete ship there will not be the same readjustment of stresses as in a steel ship when subject to the action of a heavy sea, experience with reinforced-concrete structures generally has shown that such structures have considerable elasticity, and there is ample reason for the hope that reinforced concrete will prove a suitable material for shipbuilding purposes."

One of the questions in concrete shipbuilding concerns the possible effects of sea water on concrete. Recent investigations by the Bureau of Standards, as reported by Messrs. Wig and Ferguson, throw new light on this subject and point out remedies. The results of their investigations tend to show that inferior concrete, or concrete of which the surface skin has been impaired, suffers serious effects when in contact with sea water, and that great care in the mixing, placing, and finishing of the concrete is needed for durable construction. There is every reason to feel assured that the care needed in the selection and proportioning of materials and in mixing and placing and finishing concrete for concrete shipbuilding will provide the proper remedy.

Another aspect is the protection afforded the reinforcing steel by the concrete, and in this connection the investigations of the Bureau of Standards show that portland cement itself is durable in sea water, which suggests that the rich mixture of concrete used in concrete ships, if properly deposited around the reinforcing steel, will provide the requisite protective coating.

Besides the work now under way which has been mentioned, plans are nearing completion for the construction of other vessels on the Gulf and Southern Atlantic coasts, so that in the course of six months there should be much more detailed information available on the subject. The art of concrete shipbuilding might be said to hold the position occupied by reinforced concrete fifteen years ago, but the knowledge gained during these years is helping to solve the present problems, and we may be sure of a rapid development in this hitherto unrealized field.

In the report of the Canadian Department of Marine and Fisheries for last year, recently made public, the opinion is expressed that no form of industry has a brighter opening in the Dominion than shipbuilding, and it has in fact already made a rapid and substantial start.

Ships to the value of $60,000,000 to be constructed in the Canadian yards this year are reported to be already under contract. Included in this amount are orders for vessels amounting to $25,000,000, placed on behalf of the Admiralty through the Imperial Munitions Board; 100 others are under construction at plants in various cities throughout the Dominion, as well as certain craft regarding which information cannot be given. In this situation of the shipbuilding industry, necessitated by the demand for tonnage to meet war conditions, the British Controller of Shipping, the British Admiralty, the Imperial Munitions Board, and two departments of the Canadian Government have had a part. (*Journal of Commerce*, March 14, 1918, p. 5.)

THE WAR'S EFFECT ON MERCHANT SHIPBUILDING

By HOMER L. FERGUSON,[1] NEWPORT NEWS, VA.

IN a military sense, this war is narrowed down to the question as to whether the German submarines can sink the English ships and those of the Allies at such a rate as to force peace upon Great Britain, ourselves and the other Allies before the Germans are sufficiently thrashed on land to recognize that fact. When the submarine campaign was started in February, 1917, the German Minister of the Navy promised his people that in August of that year England would be brought to her knees. The rate of sinking for a time increased until it became probably three or four times the rate of building.

There have been two schools of thought regarding the proper method of meeting the German submarine campaign. One school has held that only by the production of the maximum number of ships in the shortest space of time, until the production of new vessels should more than equal the destruction of vessels in being, would the question be answered. The other school has held that there were vessels in plenty to feed England and to carry our troops to France and to feed them, and that the proper method to meet this menace was to build a large number of submarine chasers, destroyers and other vessels of war to go after the submarine itself.

The exponent in an official way of the theory of building the maximum number of ships is, of course, the United States Shipping Board, with the Emergency Fleet Corporation as the largest individual owner and builder of merchant ships anywhere, either at this time or at any other time in the history of the world. All of the shipbuilders have had their new ships commandeered by the Shipping Board, and these ships are now being pushed to completion under the direction of the Shipping Board. In addition to the ships under construction at the time the Shipping Board took over all these vessels on August 3 last, the Shipping Board has placed contracts for 200 to 300 additional steel ships and for about 200 wooden and composite ships. The English have built ships at a very rapid rate during the past six months, but prior to that time their capacity had fallen off woefully. The figures of British shipbuilders are that in normal years their capacity in tons was about two million. In 1915 they built only 700,000 tons. In 1916 only 550,000 tons. In the first six months of 1917 they built 500,000 and by the end of 1917 they will have built during this year almost two million tons, or practically their normal tonnage.

In comparison, it is interesting to look at our record, which is mostly to be made in the future. The largest tonnage ever built by us in any year prior to 1917 was in 1908, when we built 615,000 tons. In 1917, or at the end of the fiscal year of 1916-17, on July 1, the total tonnage turned out in merchant ships in this country was close to 800,000 tons. Of course, we expect this to be bettered very much, and except for labor difficulties the production would have been very much greater; but it is a far cry from 800,000 or 1,000,000 tons of ships a year to a prospective 2,500,000 to 5,000,000 tons of ships a year, and especially when we consider that the best the first shipbuilding country of the world ever did in any one year was only 3,000,000 tons.

Now as to the methods of turning out such an enormous tonnage in a short time. The standardized ship was first thought of by Noah. It certainly would have been had he built a second ark. Every other shipbuilder has thought what a joyful thing it would be if he could only build two or three or four ships just alike. If the war does nothing else for shipbuilding, it will at least demonstrate that the individual tastes of individual owners need not be met in every instance. Building a ship is somewhat like building a house, and I dare say even the ladies present will agree with me that none of them has ever seen a house built which they would not change here and there—certainly in closet space if nothing else; and it is very much so with ships. Ships are not built alike for the reason that ships are built by units and tens instead of by thousands. And what applies to the automobile industry or hat industry, or any other industry where the units are small and the aggregate number is very large, is not possible where you are building a thing that is worth half a million or a million or more. It is certainly not possible under ordinary circumstances with a very scattered ownership. But with a single ownership, like the Emergency Fleet Corporation, it becomes possible for the owner to specify that all ships shall be alike, and thus we have standard ships!

There is an idea extant that if a ship is called "fabricated" or "standardized" it becomes rather easy to build. It does become easier to build, but it is not any easier to drive a rivet in a fabricated ship than in a common ship, and the 7500-ton fabricated ship will have about 650,000 rivets and some riveters must do a considerable amount of work to drive those rivets in that ship the same as in any other ship. The most onerous work in building a ship is in the driving of the rivets; and if any concern is going to build one ship a week it must drive 650,000 rivets a week. When we consider that the best rivet drive is by the Union Iron Works, where they drive 250,000 rivets a week, and the next best by the three largest shipyards on this coast is about 200,000 rivets each per week, the problem of driving 650,000 rivets a week assumes a rather difficult aspect to the casual observer.

The fabricated ship has the center of the stage at the present time. In England a standardized ship was adopted which is very much like a fabricated ship, and they are being turned out at a rapid rate. The first ships have already been completed and are now on the sea. The fabricated ship, like the English standard ship, has the disadvantage of low speed, and at the same time it has the advantage of a large carrying capacity. The records of submarine sinkings, such as have been gathered, indicate that speed is probably the safest defense against the submarine. The number of very slow ships sunk is very great in proportion to the number attacked. Probably 90 per cent of the slow ships are sunk when attacked by a submarine. As the speed becomes greater the immunity of the ship from torpedo attack becomes greater—not only because she presents a more difficult target, but also because the vessel may run away from the submarine in darkness or in daylight if she has a greater speed than the submarine has on the surface, and also because the vessel may be maneuvered much more quickly.

One of the most gratifying things about submarine warfare is that the torpedoes are not making as great speed as in the early days of the war. The speed of the torpedo has undoubtedly become much decreased. Just why we do not know, although it is probably due to the absence of tungsten and

[1] President, Newport News Shipbuilding and Dry Dock Company.

Abstract of address delivered at a joint meeting of the Engineers' Club of Philadelphia and the Philadelphia Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, October 16, 1917.

manganese and some other ingredients now so difficult to obtain in Germany. Vessels of 16 or 17 knots have actually dodged the torpedoes.

The vessel of 16 or 17 knots is also needed to carry soldiers. We are shipping all our soldiers to Europe in vessels of 14 knots or over because it is thought to be too hazardous to ship them in the slower vessels. We have at the present time in this country enough vessels in commission to ship soldiers to Europe at the rate of not more than one million a year. That includes all vessels of 14 knots or over. But by building a large ship, as well as a speedy ship, an additional factor of safety is obtained, which may be illustrated by stating that a torpedo will blow just as big a hole in a little ship as in a big ship. When a small, short ship has a large hole in it, a relatively larger proportion of its length is open to the sea. When a similar hole is blown into a long ship, a very much smaller proportion of that vessel is open to the sea. So that it is perfectly possible to design, and practical, indeed, to design a ship 500 or 600 ft. long, so subdivided that it will take two, and probably three, torpedoes of the German variety and still stay afloat.

The design, however, must be of such character that when the compartments are flooded the ship will still remain upright. The requirements of passengers who go to sea are such that the ordinary passenger ship shall have a very small metacentric height. But with a small metacentric height the rolling of the vessel is very easy, so that the passengers are not made ill with the motion of the ship as easily as they would be if there were a large metacentric height and the ship rolled quickly and with a jerk. Ordinary passenger ships are modeled with a small metacentric height, and three-fourths of them, when bilged or torpedoed, will probably turn over before sinking.

A great deal of talk was heard years ago, when the *Titanic* went down, about making ships safe. The *Titanic* was probably the safest ship that ever crossed the ocean, with the exception of the *Olympic*. The *Empress of Ireland*, the *Lusitania* and the whole host of passenger ships of which we have any record have turned over as they went down, and they probably righted after they went down. In designing a ship that will be safe against submarine attack, not only must the question of subdivision be taken care of so as to limit the length of the vessel that may possibly be damaged by a torpedo, but also the stability, so that when torpedoed the vessel will remain in an upright position and will be able to get into port.

The larger type of ship which will probably be built before the war is over by a number of concerns in a position to undertake this work will be designed with a high speed for troop transport, with a close subdivision to make the ship safe, and with a large amount of stability so that the vessel will also be safe against turning over.

The war so far has developed three distinct types of vessels: the standardized or fabricated ship, such as both England and the United States have adopted; the large troop transport which has been described; and, in addition, the submarine chaser.

Besides these three types there has been a very definite attempt to rejuvenate what some of us have considered a dead industry. I do not know whether many wooden ships are being built around Philadelphia, and I would not like to criticize the wooden-ship builders; but I should like to see a few. We have a few of the older wooden-ship builders left, but the building of a wooden vessel to my mind is so much more difficult than the building of a steel vessel, and requires so much higher skill than does the building of a steel vessel, that I wonder how one can ever expect to build them.

I do not believe that a 288-ft. wooden ship built in a lumber yard, either South, West or North, and necessarily by men who are not expert ship carpenters, will ever relieve any great distress on the other side of the water caused by lack of fuel or food. On the other hand, these wooden vessels may be used in our own trade at home. My chief regret is that they are not made shorter, because when such ships are over 200 ft. long it is rather difficult to hold the ends up. If we can get more vessels by building wooden ships, let us build them, but it is unfortunate that the type was settled before many professional wooden-ship builders were on the job. The wooden-ship builders, of course, have taken a good many men from the steel-ship yards, and have lessened production to just that extent; but, on the other hand, they will add a very considerable tonnage, now that practically all our large coastwise ships are either going abroad or are in the way of being commandeered for foreign service, so that the wooden ship will serve a useful purpose.

The standard ship probably offers the best opportunity for a large increase in our tonnage. The standard ship has been built on the Great Lakes for years. Shipbuilding there has become largely a manufacturing operation for the reason that the ships themselves simply form a part of the manufacturer's business of carrying iron ore from Lake Superior down through the Canal to the eastern points, where it is shipped to the steel furnaces. The loading and unloading of the ore permitted the standardization of docks, hatches, and so on, and the method of construction became standardized because the work which the ship did was standardized. Many ask why we do not build ships just as they do on the Lakes, and the answer is that we do not do the same work that they do. On the coast, with the coal trade, there has been some effort toward standardization. With the standardized ship the main benefit is not in the hull of the vessel, or in the fabrication of the vessel in the steel mill. The main benefit is that the machinery and the outfit, the winches, the pumps, the steering gear, the engines and boilers, and all the thousand and one things that go into the ship, are standardized, and may be produced in large quantities at some point other than the yard of the builder. The standardization of the fittings of a vessel is more important to my mind than the standardization of the hull. The amount of money saved in the latter will be that required to build the templates, patterns, etc., amounting to not more than 12½ to 15 per cent of the labor cost of the hull. We are told, too, that all the riveting will be done at the steel mills. It probably will not, and if 20 per cent of the riveting is done there, it will be more than I think, unless the railroads will carry pieces of steel as large as this auditorium.

Shipyards have naturally tried to standardize within their own practice the fittings that go on the various ships they build, and a great step is being made in that direction by one of the largest corporations in the country. The Bethlehem Company own so many shipyards that they are in a position to standardize as between their various yards, with the result that there will be considerable saving in cost and in time in the production of all the things that go into a ship.

But in building the standardized ship, or in building any other ship, the real problem is not the problem of equipment; it is not the problem of money even; it is not, except in part, the problem of location, but it is the problem of men. A very simple lesson in arithmetic will indicate that if 100,000 rivets are to be driven in one day, and any one gang of riveters will drive 300, then it will take so many men and boys and helpers

to get that drive. It is quite desirable to get back to our arithmetic again when we have built so many ambitious high hopes of what we expect to do. I can state for our company that the most fortunate thing we did when this war started was that we promised to deliver ships only in the quantity that we had been delivering before.

Saying that we are going to do a thing does not do it, and *hoping* that we are does not do it, and promising to the newspapers that we are going to build all these ships does not do it. As a matter of fact, enthusiasm and high hopes, unless counterbalanced by good judgment and experience, do more harm than good, because a good many people are lured into a sense of security that we are going to win against this submarine menace, when, as a matter of fact, there is nothing to justify any such conclusion. For instance, on the Delaware and on the Chesapeake, which we, on the Chesapeake, are pleased to consider the two largest shipbuilding communities in the United States, there are at present about 33,000 men employed in the shipyards. There could be employed to advantage in these same yards at this time a total of 48,000 men, and within the next six months, or the next nine months at the latest, these same yards, barring the fabricated shipyards, could employ to advantage a total of 60,000 men. So the problem becomes arithmetical again. There are 32,000 men working. To get the maximum production out of the shipyards already in existence, 60,000 men will be needed. Where are the 28,000 extra trained shipbuilders to come from? Add to these shipyards the fabricated shipyards, which on the Delaware will probably require 20,000 men, and in the vicinity of New York an extra 10,000, and we have in this immediate district need for approximately 60,000 new mechanics in the shipbuilding business.

According to Admiral Capps, there will be needed in the whole United States in shipbuilding within the next six months an additional 150,000 men. Now consider for a minute where these men must come from or how we are to get them. In the first place, most shipbuilding men or mechanics require both skill and experience. We can give them the experience fairly quickly, but we have not time to give them the skill. In other words, it is necessary that men be recruited from industries where they do work similar to the work of shipbuilding. I say other industries without specifying what particular industry. Of course, it would be natural to pick the non-essential industries, if there are any such. But I would say that they should be taken from *any* other industry if necessary, because our problem in the war becomes the most difficult when the question of transportation is considered.

We are operating or preparing to operate 3000 miles from our base, and that is the crux of the whole question. A reasonable solution has been proposed for every physical problem presented by this great war except the problem of oversea transportation. The problem of oversea transportation absolutely has to be met before we can get into the war effectively, and the problem of sea transportation is probably the most difficult of all problems we have to face. Therefore, the men should be furnished for the solution of this problem, no matter what industry they are taken out of. We are making a fine, large army; we are making all kinds of quartermaster supplies and guns, and other things, but none of them are of any use whatever unless carried to Europe. Our soldiers must be carried to Europe, and not only that, but the soldiers that are carried to Europe must be fed and must have ammunition. The excitement created by the war so far will be but a gentle zephyr compared to the excitement that would permeate the United States if, perchance, we should get a million men in France from the United States and they should go hungry. My own opinion as a plain American is that that is the largest problem that looms up in the future. It is a military problem of prime importance—the most important single problem that confronts us at the present time.

I have been quoted in an extract of this talk that I gave to the newspapers as favoring the conscription of laboring men. I do not say that I favor the conscription of laboring men, but I do say this—that sooner or later the United States will tell all men who are essential in any industry or any occupation in the prosecution of the war that *this* is their job, and they are to stay by it until the war is over. It is ridiculous that our men who are already in Europe and those who are going there now should suffer on account of some difficulties that arise between employers and employees in the great shipyards of this country. Not only should the man who pounds iron and drives rivets be told that he shall be kept on his job, but also every employee in the company, from the president down to the office boy, that he is to do the same thing, and is not to seek or obtain other employment, except for good reason given the Government authorities. It simply comes down to this: Whether we are playing a game of amusing ourselves, or whether we are in to win. If we are in the war to win, no one should be timid about telling the laboring man or the unions, or anybody representing them, just what part they have got to play along with the part that other people should also play. In fact, when the war started a few of us in conversation with the Secretary of the Navy told him that we thought the thing for him to do was to commandeer the shipyards, together with all their employees; to put us all on the Government payroll if he wanted to do so, and give us as many stripes on our uniform as he thought proper, and if we did not do as he thought the United States wanted us to do to court-martial us and send us down to Atlanta or some other convenient penitentiary. And I think something of that sort should be done. Any man who has charge of shipbuilding or engineering in any capacity who is not perfectly willing that that should be done both to himself personally, as well as to his men, has a very one-sided view of this war which needs to be corrected. Of course, it is held by the National Council of Defense and by a number of exalted bodies that the *status quo* as between employer and employee should remain the same during this war. Of course it should remain the same, and we all know that it is not remaining the same, and we all know that the labor leaders, as a rule, are unable to control the men.

There is a solution of this labor problem effected with the transport workers on the other side; Liverpool, for instance. A number of the soldiers were sent back to Liverpool and went to work. A few years ago in France a great threatened strike on the railroads was settled by making soldiers out of all the railroad employees. Our present stevedore troubles are in a fair way of being settled by giving the colored man a chance to be a stevedore instead of being a soldier in the trenches; and so far as I have been able to observe in our neighborhood, several thousand of them are glad to take advantage of this glorious opportunity, and are stevedoring for their country very quietly and very effectively. I do not see why of all the men who have been passed into the National Army that we should not have in so essential an industry as shipbuilding those of them who are mechanics on conditions set by the Government, and on pay to be approved by the Government, to work in these shipyards until the war is over, or until they should perchance prefer to go to the front instead of staying in the shipyards.

I understand that in Philadelphia it is very difficult to have

any of the shipyard employees excused from military service. Of course, they have their own rules to go by in Washington, and we must all abide by them, but it is rather unfortunate that they should be differently interpreted in different parts of the country, and it seems to me most unfortunate that the shipbuilders have been allowed to go to the front. The experience of England was that they had to take out of the trenches not only the shipyard workers but the ammunition workers, and send them back to the factories again. It is a pity that we could not profit by that, but I suppose we will after we have gone a little further into the war. That would be a solution that would help very much with this laboring-man difficulty.

Of course, the real trouble with the employers of labor is they are told that they must get together with the men and must have no trouble during this war; that they must keep the plant going. Every manager that I have talked with feels that it is incumbent on him as a good American to see that the wheels are kept going around and that these ships are produced, and I dare say that all the employers are perfectly willing that they should fight with their own laboring men, and fight to a finish if need be, except at this time. We all know what that means. The demand is largely in excess of the supply of men. The sympathy of the Government is with the men. At our Navy Yard, under the law, we pay the going rate in that vicinity, and arbitrarily fix the rate at a larger rate than the going rate in the vicinity which we have to meet, and we are told in case of difficulty we must keep going, so it is only a question that can be worked out by the Government's representatives and the shipyard employers together.

I would be perfectly willing to see all the shipbuilders go down to the Navy Department and Shipping Board and say, "We will agree with you on these conditions and stand by them, and will shut up our shop before we pay any more." Of course, it can be said that a man who works is entitled to any wage he can get. Perhaps he is, but he is not entitled to stop working now, and he is not entitled to say that any other man shall not serve an apprenticeship now. He is not entitled to say that a helper shall not do a mechanic's work if he can do it. How perfectly ridiculous when a million and a half of the best young men that we have in the whole United States are serving an apprenticeship in the war, leaving their homes and going out to learn the art of soldiering in a very short time, and quite as difficult work to learn as riveting. What a ridiculous thing to say at a time like this that a man cannot get a job unless he has served his time at the trade, and tie the hands of the United States in this great war, which it must win if you and I are going to keep on being proud of living in the United States.

I was shown today in the case of a number of workers that the money which they could earn in a day was limited by the organization to which they belonged, and that if they earned that much money at two or three o'clock in the afternoon they would work no more, notwithstanding the fact that the management wanted them to do it. When will people ever learn that production by the use of labor-saving machinery to get a large production per man is all that gives us more than we ever would have otherwise, or than we ever would have had before the days of large production? And yet they have limited production with the idea of giving more jobs to more men in time of war when we have not got enough men and have about three jobs for one man!

I will take just a little bit of your time in presenting what I might say is the worker's side of the story. I do not know the conditions in Philadelphia, but I imagine they are rather bad for laboring men. As an instance of what can happen, in Newport News, a town ordinarily of 30,000 people, we now have 55,000 people. The place is so full of people that no one can even go there to see the soldiers off. The condition of laboring men who are gradually coming in from the West to all the seaboard towns is a very difficult one, and a great deal of the basis of discontent is a lack of suitable housing conditions. That is ordinarily taken care of in the towns and cities by real-estate people and those who build for investment, but at the present time that method is wholly inadequate, and this question will have to be considered along with the same program as that for our Army which is being installed in cantonments all over the United States. Why? Because we cannot find vacant houses for 20,000, 30,000 or 40,000 men in any one place, and so quarters have to be provided the same as for the soldiers.

The Government is waking up to this situation in the case of some recent contracts let for destroyers. The Government itself will finance the building of barracks or temporary hotels for the men, so that several hundred can be housed at or near the shipyards where the work is to be done. For instance, in Philadelphia you have large fabricated plants to be built, and you have a number of large war industries settled here. In addition, Essington will need probably 20,000 men and the fabricated-ship yards probably 20,000 or 30,000 more. It becomes necessary even in this city, which is known all over the country as the best workmen's city in the United States, that the housing be looked into, and that large additional facilities be quickly provided. One of the biggest problems England had was the formation of new communities and the building of whole towns. In some cases they were almost ten miles square, and in them were provided not only ordinary houses and living accommodations, but public parks, playgrounds, theaters and everything needed in a modern town.

[Mr. Ferguson continued by referring to the need at this time for patriotic service to the country on the part of all alike, regardless of the group or individual. He could not imagine the United States letting stand in its way any band of men whatever when National honor and life depend on our winning this war, and we are sending our young men to France by thousands. The Government might exact any toll so long as all were treated alike and business was left with enough money to carry on its operations, pay a moderate return to the owner and be able to serve the Government in the best way.]

The Chamber of Commerce of the United States, representing many business men of the country, at its meeting at Atlantic City, gave voice to this sentiment: that if they treat us all alike they could not go too far in exacting the greatest toll from the business of the United States. We are willing to have the plants commandeered by the Government, under the terms of the United States and under conditions which they see fit to impose; but we insist that managers, foremen, superintendents and men shall all be treated alike.

With reference to the difficulty in securing priority in the delivery of material, I would say that we have received from the Navy Department and from the War Department and from the Shipping Board orders to proceed with the utmost vigor and despatch to do their work, each in the same tone of voice, each with equal authority, all vested in these various departments by Acts of Congress, so that actually what has happened is that the president of our company has had to settle the question of priority himself—an entirely improper function for him. The question of priority and preference is now the biggest industrial question there is, for

the very simple reason that the total production of the United States has been over-absorbed by these war activities.

With the prices settled, the only important thing is, who gets his first, who second and who third. The Government wants to get the material in such quantities as it can, but it is simply impossible to satisfy all these bureaus and departments. What is the answer? The answer that was found in Great Britain in the very first months of the war was to divorce the question of business, buying and price-fixing from the naval and military activities of the country. A munitions minister was appointed; just the kind that we need. The same chamber of commerce I was speaking of recommended that a board be appointed. I am a director in that chamber, but I think a minister should be appointed, because you want a *man* who will coördinate the interests of the country, and when blankets are necessary he will buy blankets for the United States, and not buy three blankets for the sailors and none for the soldiers.

The weakest point in the shipbuilding business is the forging situation, in my judgment. There are not enough forges in the United States to turn out all the forgings required for the shipbuilding. The great Bethlehem Company, Midvale, and the Allis-Chalmers are practically the only large ones we have, whereas Great Britain has twelve or fifteen very respectable forging concerns. It is absolutely necessary that some one determine whether this or that or the other kind of forgings shall be first; otherwise a lot of us are apt to end up with hulls but with no machinery to put in them. It seems to me that we all want to do the best we can, but we would very much appreciate it if we could go to Washington and say to some one that this is the most important, and that is the next, and that is the next. Instead of that, we appeal from one department to another, and the result is that we frequently end up with nothing.

I hope that the good people in Philadelphia will always maintain an open market for beginners in the shipbuilding industry, and when the Shipping Board works out its program of breaking in new men and bringing them in from the West, then every one in our business will do his best to give a helping hand. We invited the Board to bring its school to Newport News. I think they have been invited by one or two Delaware shipyards to establish a school for the instruction of teachers who would go back to their home yards to break in all of the new help. We have to break in large numbers of new men, and the most important question next to the housing question is the breaking in of these new men, and our foremen and superintendents must get used to the honor of subjecting themselves to the discomfort and inconvenience and annoyance of breaking in large numbers of perfectly green, raw country boys.

We all know that it is a joy to have a few good mechanics and give them a job and forget about it, but we have to get away from that and to teach new people, which may fortunately be done with ships of standard make and duplicate makes. The problem that the employment managers have at the present time is to get hold of the best material possible, house it as decently as we can, and teach it shipbuilding as quickly as possible. The problem almost dazes one to contemplate. It can only be solved by bringing in enormous quantities of new men, and which must be done without any hindrance. The leaders of the unions have stated that they would allow this to be done. We have to do it, and no matter what else happens we must insist upon the right to break in any number of new men in the business. The Shipping Board will back it up, and I am sure that sooner or later the Administration itself will insist upon that being done on such a comprehensive scale as to make it possible for the United States to carry out its great shipbuilding program, which *must* be carried out.

OUR INDUSTRIES AND THE WAR

A Timely Discussion Before the New York Section on the Open Question of the Adjustment of Our Industries for Effective War Work

FACED with the diametrically opposed conditions, on the one hand that several billions of dollars are being spent by the Government upon manufactured products for war purposes, inflating and seriously taxing one set of manufacturing resources and, on the other hand, rendering it necessary to limit production in other lines not directly essential to winning the war, and the disruption of those organizations, the industrial situation today calls for an adjustment which, if not approached from the standpoint of the welfare of the nation, is liable to produce, and has unfortunately already produced, disaster in some channels. The common ground for attack of the two-sided problem is, of course, unbounded patriotism and the desire to win the war as soon as possible, and it is to the credit of the manufacturers mostly concerned—the small manufacturers whose activities are at the present time apparently not available for mass production—that they have approached the problem on this ground, and many have made sacrifices worthy of the cause. At the same time, however, there is the other side—the protection of our industrial organization as a stabilizing element during the war and a subsequent economic necessity.

With the hope of developing some of the facts in the case as a means of bringing out some constructive suggestions to meet the problem, the New York Section of the Society organized and conducted an impartial meeting on the evening of February 21, to which a number of prominent manufacturers were invited to express their views. The following is a brief account of the protracted meeting, which culminated in a definite recommendation to the Council of the Society to take action in the form of appointing a committee to act as a clearing house to bring the requirements of the Government to the industries, so distributing work that the resources of the nation would be made completely available.

GEORGE K. PARSONS, in opening the meeting, said that it was to be regretted that the term "non-essential" had ever been applied to industry, since it was misleading. Essentiality is a relative term, and no industry exists which cannot contribute in some way to the demands of war. He cited a report from the London *Economist*, showing that while luxuries were now less in evidence in Britain, no British industries had been destroyed—they had merely been converted. He said that organized professional engineers could and must use their peculiar and particular abilities in publicly and privately helping industry to accommodate itself without upheaval to the problem of winning the war, and to help the

Government in such a way as to make the application of drastic measures unnecessary. The object of the meeting was therefore to see how engineers could promote the essentiality of the various industries.

Secretary Rice emphasized this object by stating that it was the duty of engineers to help solve the problems of the Government. It was especially their duty to discuss the subject of conversion of the industries, as it was impossible to carry out such conversion without an engineering analysis. He said that industrially the problem of the Government is to secure the necessary supplies for the conduct of the war. The second problem is to insure continuance of our industrial strength during and after the war. He described a plan of the Fuel Administration which, by applying fuel curtailment to certain industries, automatically provided restriction of non-war industries. This plan had already proven practicable, and industry had given its hearty support to it. The actual effect of the plan was to limit production of non-essentials.

President Main congratulated the Section for taking up its share of public work. He hoped that the meeting would result in some constructive suggestion which could be made to the owners of non-essential plants, who were looking to engineers for assistance in getting the Government to utilize their facilities for making, perhaps, small parts of munitions.

Frederic W. Keough, editor of *American Industries*, official organ of the National Association of Manufacturers, declared that it was impossible to prepare a detailed classification of essential and non-essential industries, as there was no such thing as a non-essential industry. Many products which seemed at first thought to be non-essential in wartime might be just the things to send abroad instead of gold in exchange for essential raw materials. He thought we all ought to be eager to promote war work, but in doing so there was no occasion to tear down our industrial structure which we would probably need very badly to meet foreign competition at the end of the war. Manufacturers generally were not only "doing their bit," but were doing their utmost of their own accord to convert their plants to war purposes and to supply men for war work. He urged that no drastic action be taken to curtail industry, but that the engineers tell the manufacturers how adjustments may be made with the least friction and waste so that all their resources may be applied to the common good.

Horace B. Cheney, of Cheney Bros., South Manchester, Conn., wrote that it might very well be that the industries most necessary now for military success would be of the very least value at the termination of the war, and when that time comes we must not find our industry in a position from which it will be unable to arise and quickly meet the ordinary business of life. He thought it was possible to make a rough estimate of what the Government needs for war purposes, such as ships, munitions, clothing, food, etc., and what the civil population needs, beginning with food, clothing and shelter, and what the country needs or may need directly after the war and thus arrive at an idea of the relative value of industries. The best way to find out how an industry can be of most use in the war is through the trade associations, which are already in many instances conducting distribution of raw materials as well as furnishing information regarding stocks and needs of industries.

Past-President Hollis said he had never been able to distinguish between the essential and the non-essential industries. He said that while a great many of the smaller industries had been willing to make sacrifices and to help in the war, it had never been made quite clear how they could help best. He thought it was for the engineer to instruct the manufacturers and the public in that particular so that no industry would be sacrificed unnecessarily. He thought that one essential industry which the Government had more or less lost sight of was the "college industry." Up to this time no way has been found by which our boys who are being trained to take their places in the industries can be left free to obtain their training without the feeling or imputation that they are slackers. He thought that our Society could help out in this situation by educating the people as to what is best for the future.

P. W. Henry, vice-president of the American International Corporation, evidenced the absolute necessity of curtailing the manufacture of certain products if the Government is to carry out its war program. The Government should work on the public and emphasize the need of its limiting its purchases to bare necessities in order that the Government may have at its command the men and material necessary to produce the articles it requires. To this patriotic appeal should be added a system of taxation so drastic as to compel every individual to curtail his expenditures for non-essentials. This would not mean the cessation of the manufacture of non-essentials, for these factories could still continue their business for export, which is necessary in order to stabilize exchange. There would be a slump, of course, but every manufacturer of this class must expect to have his plant put on part time sooner or later, and it behooves him to get in touch with the Government to find out for what articles needed in the war his plant is particularly adapted. He, knowing his business, should take the initiative in bringing the Government and himself together on a mutually satisfactory basis.

Wm. Hamlin Childs, president of The Barrett Company, declared that there is no such thing as a non-essential industry. The non-essentials will be taken care of by arrangement between the parties interested—in other words, they will take care of themselves. A good many plants will do different things from what they have done before, but they must be preserved to go back to their old conditions after the war is over. He did not believe there was a class of men whose spirit was more energetic for the public good than the manufacturers of this country, and they should offer, and continue to offer, their advice to the country until this question of the industries is settled right.

Frank Mossberg cited the case of industries which were willing to take on Government manufacture, but found it difficult to get the work. Many of the small manufacturers were not in the position to go to Washington to secure an order, and therefore, if the case of these could be brought to the attention of the Government, something might be accomplished.

He mentioned that in southern Massachusetts some 10,000 people were employed in the jewelry industry. He did not know what would become of these people if their factories were closed down. He thought that if, on the other hand, they were given other lines of work which would be of service to the Government they would work harder than before. That would surely be much better than stopping their work entirely.

C. R. McMILLEN, vice-president of the Union Bag & Paper Corp., suggested more earnest consideration of the need of industrial coöperation as the means to the economic betterment of business. He considered that all business may be divided into three classes—directly essential, indirectly essential and non-essential. All productive business is essential, and every idle dollar or person capable of productivity is a burden on the nation. Labor employed in semi-essential or purely non-essential business may be unfitted for the production of essentials, and if unemployed becomes a carrying charge, a cost, to the nation. It would be well for the Government to issue bulletins indicating kinds of experience or labor, materials, buildings, plants, machines, tools, etc., wanted, so that all resources may be utilized where and in what manner they are most needed.

J. R. HAAS, secretary and treasurer of Loft, Inc., New York, entered an interesting argument for the classing of confectionery as an essential since it was a food. He said that in 1906, when the pure-food law was framed, candy was included in its operation, and that in the city of New York the Department of Health maintains a pure-food division which inspects candy factories, classing their product as food.

ERIK V. OBERG made an able presentation of the manner in which the problem of the non-essential industries had been handled in England. In that country they have not forbidden any kind of business; on the contrary, all kinds of business have been encouraged to go on exactly as in peace time, provided they can do so without taking material necessary for war purposes. Such manufacturers cannot get iron and steel, nor practically any other metals, so that in the iron and steel industries very little is being done except war work.

Mr. Oberg also described how England had handled the labor problem under the War Munitions Act, not a paragraph of which but was not first agreed to by the Government officials, the manufacturers' associations and the labor officials in joint conference.

ELLIS L. HOWLAND, one of the editors of *The Journal of Commerce*, wrote that the answer to the question what are non-essential industries depended entirely on the viewpoint of the judge. No man who has worked hard to create a working entity which has served the public likes to be told it is non-essential. It is not in normal times, but when our national needs are distorted it may be truly dispensable as compared with the one thing needful. The decision must rest with one power, the Government, and with its superior opportunities for knowing all angles of the situation, hasty condemnation of its decrees is not to be encouraged. Once a decision is rendered, however, common sense ought to dictate that any upheaval of normal conditions should be made partial rather than total. With business men sharing in the responsibility of necessary adaptation, better results will be obtained than when inexperienced dictation prevails and practical opposition stands in the way.

He believed the best way to win the war was first to arouse and inspire the patriotism of the business man, coördinate him with the Government, get to a common understanding and above all a mutual respect and confidence, and then let the business man carve out his details as he will.

STERLING H. BUNNELL said that it is impossible to win the war without hardship. It is not to avoid loss of profits by the manufacturer and his organization that any should protest against the limitation of the work of any plant or industry, but rather it is to avoid reducing the output of the United States. We need every ounce of effort of every citizen. The authorities should never stop a man's work in one line without putting him instantly into another job more necessary. This condition is an ideal impossible of full attainment, but its attainment is worthy of a strong and continued effort. Let us think of the situation as needing not the limitation of non-essential activities. In this way every plant and every organization available for any part of the essential work of the United States should be utilized, and then the few remaining non-essential industries could safely be left to take care of themselves.

D. D. JACKSON, professor of chemical engineering, Columbia University, said he wished to correct the impression that the Government has forgotten the colleges, and has considered them non-essential. As a matter of fact the Government has asked the scientific schools to pick out one-third of their men and have them enlist and then return to the college to complete their scientific courses.

As an example of what might usually be considered a non-essential he mentioned photography. He said that under the auspices of the War Department a war school of photography had been established at Columbia, and was turning out a hundred men a month for foreign service. He thought there was no question but what every line of business could be modified so as to be applied directly or indirectly to war work.

At this point the chairman called for a brief, sharp discussion of what the engineer was going to do in this matter of the industries.

SPENCER MILLER, in responding to the request, said it seemed to him that so far the meeting had been somewhat one-sided. He vigorously assailed some certain things as non-essentials, and said that if we did not school our appetites and eliminate these we would lose the war and would deserve to!

He suggested a higher degree of specialization on behalf of our manufacturers. One manufacturer should not make more than one thing, and should let other manufacturers take the responsibility for making other things. If they would do that they would be efficient and could do essential things.

FINLEY R. PORTER called attention to a situation which he thought ought to be looked into in connection with the matters under discussion. He said that at the outset of the war he tendered the Government the free use of his factory which is making automobiles, but while his offer was courteously acknowledged it had never been accepted. The Government apparently takes the attitude it wants work in large quantities. He knew of dozens—he might say hundreds—of factories that cannot possibly get work from the Government. Mr. Miller promised Mr. Porter that he would see he got some of it.

CHARLES W. BARNABY said his impression of the object of the meeting was that it was to arrive at the best means by which each individual manufacturer of non-essentials might switch over to essentials. He himself was connected with the mechanical side of the ship-equipment industry. They had plenty of work, and he imagined most of the shipbuilders had; and he thought that any manufacturers in the East who were prepared to make parts of engines and similar articles could get plenty of work from the shipyards if they only went after it or let the shipyards know where to go after them.

E. J. HUBAUX, an American of Belgian birth, referred very feelingly to the manner in which the peoples of the stricken countries have had to revise their ideas of essentials and non-

essentials. He said that while it was quite true that certain things, like food and clothing, were essentials, they were so only when used sparingly—just enough, no more. He thought we should draw a lesson from Belgium, where if they have sufficient bread to eat so as to keep body and soul together, that is enough for them.

Our aim is to win the war quickly, and everyone must cooperate. If the jewelers cannot make jewelry they can make something else—time fuses for shrapnel or precision parts for torpedoes; those who are used to making pleasure automobiles can make motor trucks or aeroplane parts.

F. A. Clawson, formerly associated with the Imperial Munitions Board of Canada, thought the point of view taken by that board was worth bringing out, and that was that there was no manufacturer in Canada who was too small but what he could be made use of. In one instance the Canadian Pacific Railway Company was given a contract for manufacturing complete shells, and instead of doing all the work themselves they got other plants in the vicinity to do whatever they could to help out. One company they went to, the Northern Electric Co., of Montreal, had only five or six lathes! He urged the Society to bring this possibility to the attention of the Government.

He considered it of little use to argue whether there are non-essential industries—there are lots of them. The main point is to win the war. If the Germans win there will be neither essentials nor non-essentials!

Andrew M. Coyle thought that what we can do to bring our industries into better correlation than they are, with the least disadvantage to those that are non-essential and with the quickest results, is to get the small industries, like the automobile factory mentioned by Mr. Porter, into action and service by some system drawn up by a committee which this Society would recommend, and then bring the matter before the officers of the Government.

Selby Haar said that since this was a Local Section meeting, matters would be simplified if everyone who had something to suggest would write to the Secretary, who would see that the proper action was taken.

Secretary Rice said he wished, if possible, to convert the impulses of the meeting into action, and he suggested that each industry represented should form its war committee. They should then have a representative from this committee get in touch with either Mr. Waddill Catchings, representing the U. S. Chamber of Commerce in this work, or Mr. George N. Peek, representing the War Industries Board, and form a clearing house through these officials so that the non-essential industries should get a chance to manufacture the things the Government needs. He thought that by this means the end sought would be attained.

W. Herman Greul said that Mr. Rice had given the suggestion that should lead into definite action, and he therefore moved that the Council of the Society be recommended to appoint a committee to take definite action toward aiding in the solution of the problem of the readjustment of the industries, leaving it to the committee to determine how best to carry out its work, but following somewhat along the line suggested by the Secretary of creating a body to do something the Government, apparently, cannot do.

The motion was heartily seconded by Mr. Miller, who observed, however, that too much expectation should not be placed upon the ability of such a committee to make a very great impression at Washington, where the officials were already overburdened with thousands of suggestions. After a brief discussion, Mr. Greul's motion was carried unanimously.

FUEL CONSERVATION

With Special Reference to the Saving of Coal in Connecticut, as Outlined by Prof. L. P. Breckenridge, of Yale University, and O. P. Hood, of the U. S. Bureau of Mines

A CONSIDERATION of one of the country's vital war problems dominated the first meeting of the newly organized Connecticut Section, held under the auspices of the New Haven Branch on November 14 last. An account of the meeting appeared in the December 1917 issue of The Journal. There were two sessions, both devoted to the subject of fuel conservation. At the afternoon session Prof. L. P. Breckenridge, Mem.Am.Soc.M.E., delivered a paper on the Problem of Fuel Conservation, in which he presented some very interesting data on the production of coal throughout the world and also, in more detail, the production in the several states of this country. He illustrated his remarks by charts which he later exhibited at the Annual Meeting of the Society and which were published in the January issue of The Journal. The paper called forth discussion from Professors Seward, Perry and Barker, and Messrs. R. J. S. Pigott and A. J. German. Mr. T. W. Russell, fuel administrator for Connecticut, also participated. The following resolution was adopted:

> Voted, That the Connecticut Section of The American Society of Mechanical Engineers instruct the chairmen of its several branches to name a committee on fuel saving for their respective localities.

At the evening session Mr. O. P. Hood, chief mechanical engineer of the U. S. Bureau of Mines, Washington, D. C., presented a paper entitled Fuel Conservation by the Bureau of Mines, followed by a number of slides of the new Bureau of Mines Building at Pittsburgh. His address was discussed by Prof. E. H. Lockwood, Mem.Am.Soc.M.E., Mr. C. H. Bromley, Mem.Am.Soc.M.E., Mr. F. O. Wells, Mem.Am.Soc.M.E., and Professor Breckenridge.

The meeting closed with an address by the then President of the Society, Dr. Ira N. Hollis, on the part the engineer is destined to play in the twentieth century in the service of mankind.

Extended abstracts of the papers and discussions follow.

THE PROBLEM OF COAL CONSERVATION

By L. P. Breckenridge, New Haven, Conn.

Member of the Society

(Abstract of paper)

THE importance of fuel conservation is evident to all. We in the Connecticut Section of The American Society of Mechanical Engineers, who represent the five largest and

most important cities of the state of Connecticut, might well spend some time reviewing some of the features of the problem to see if we cannot think of some plan by which we can save coal.

First, let us consider general methods. The continued improvements in boiler-plant equipment have meant a great deal in the economical use of coal, but when improvements in equipment can no longer be made, the employment of better methods of firing and operating must be considered. Better methods of operating mean economical use of steam, for a very large proportion of coal is used in the making of steam. Practically all railroad coal, all steamboat coal and all public-utilities coal makes steam.

The whole question of the economical use of steam has been before the mechanical engineer for forty years, and methods have constantly been devised whereby steam can be saved. But the manufacturers have not taken this question into sufficient consideration for the reason that coal has always been cheap and, in the operation of certain industries, has entered into the cost accounts in very small quantities. But at the present time, when the price of coal has gone up and the quality is so uncertain, and when equipment which was suitable for a fixed quality of coal must serve for a fluctuating quality, the economical use of steam will of necessity have to be given much more consideration.

The question of using power economically is a very complex one, in that it is so intimately connected with the question of heating, and thus it is very difficult to say just what should or should not be done. All the large public-utility concerns are today manufacturing power for much less than ten years ago. This they are able to do on account of the careful attention and study that has been given to the economical use of power. It is fair to say that power generated in the larger stations has usually been manufactured at a much less cost per unit of output than that generated in the smaller individual plants, especially at times when the question of heating the buildings is not of prime importance.

It has been suggested that one way of saving coal is by substituting another fuel. But the question is, What fuel? All the oil that we have is needed, and gas is scarce; wood is a luxury for it costs from $8 to $12 a cord, and there is little else left.

The matter of not allowing coal to be used for non-essential purposes has been suggested. But how can one list the purposes for which coal should not be used and for which it should be used? For example, the Government has stated that if lights in cities were dispensed with, 250,000 tons of coal would be saved for the entire United States. And yet there is no one city that uses over one per cent of its coal for illumination purposes. Such an action might have a psychological effect and, if so, much is gained. It is not so much a question of saving the coal because it costs but because we cannot get it. One-third of the tonnage carried on our railroads is coal. Forty-three per cent of the tonnage that comes into New England is coal. Thus we should first devise means of *getting* coal, and then later the question of using it for essential purposes can be taken up.

This brief consideration of the general methods of coal conservation will help us to devise a plan whereby coal can be saved in Connecticut. The five branches of the Connecticut Section of The American Society of Mechanical Engineers represent five very important industrial cities. As a possible suggestion the chairman of each of these branches could appoint a fuel-saving committee consisting of three members who are familiar with the situation in their respective localities. These committees should put themselves into such a position that they could help, if asked, and would coöperate with the Government committees working on the same problem. For example, the New Haven committee might be asked to make a census of the industries in New Haven in order to secure figures as to how much coal they are using and to ascertain if they care to have some one come to their plants to look over their problem.

Again, a publication of the requirements of the fuel problem might be undertaken. A vast store of valuable material has been compiled by the Bureau of Mines and is available on application.

DISCUSSION

H. L. SEWARD emphasized the importance of keeping records in order to save coal, especially in the smaller plants. The large plants keep good records, and are more careful about such things, but for the sake of the smaller plants such records should be installed. No record system will be of much use unless one knows just what things to record. Some simple form can be devised on which can be stated the amount of fuel and water used. The total amount of coal can easily be recorded by counting wheelbarrow loads. When the daily forms are studied, the amount of coal used, the ratio of water to coal for a particular plant, and the operating conditions, can be easily ascertained.

Any system of records is bound to increase the responsibility of the man operating the plant. If he signs a report as to the basis of operation and repairs made, he knows that just where the responsibility begins and where it ends can be easily checked.

PERRY BARKER believed that in connection with the conservation of fuel in factories equipped with steam boilers, the question of the fuel loss which occurs in the operation is a matter which should receive attention, and which will ultimately show what saving can be made.

In the distribution of heat in the operation of a steam boiler, first, a large percentage of heat comes off in gas and is absorbed by the boiler; second, there is a large loss of heat up the stack during combustion; third, there is the loss due to unburned gas; fourth, there is the loss of combustible material in ashes and the material removed from the grates, and lastly, there is the loss due to radiation from the boiler.

These losses can be divided into, first, necessary losses, and second, those which can be controlled. The gases have to leave the boiler at a temperature at least as high as that of the steam in the boiler. All heat above that temperature can be cut down. By a brief computation it can readily be seen that there is a great loss of energy in a boiler plant: only about fifty per cent of the heat in the fuel goes into the boiler, and fifty per cent is lost. Seventy-five per cent of that fifty per cent could be controlled. Simple methods either in changing the form of operation or changing the equipment have reduced it 10 to 50 per cent in certain cases.

The three principal controllable losses are loss of heat up the stack, the loss due to unburned gases, and loss in the ashpit.

In considering the stack loss and the unburned-gas loss, the process of combustion should be reviewed. Coal is thrown into the fire and products are distilled off and pass through the furnace. They are burned with the air that comes through the grate or over the fire, and should go out of the stack at the boiler temperature. However, if in their passage through the furnace they do not come into contact with sufficient air or are

improperly mixed, or have their temperature suddenly reduced, they leave in an unburned condition. This is an incomplete combustion, not that of mixing gases and air, but the incomplete combustion due to the gases passing up the fuel bed. This is the well-known water-gas reaction. The carbon dioxide formed in the fuel bed passes forward, is reduced to carbon monoxide, and that in turn passes through the furnace. This sounds somewhat foreign to boiler operation, but it is surprising to find that on careful analysis many cases which were believed to be due to insufficient air supply are due more directly to the process outlined above. By examining the composition of the average fuel gases, we see that there is a possible fuel loss of over 16 per cent. Figures on the analysis of gases through the furnace show the combustion loss to be six-tenths of one per cent.

What can be done to control the loss of heat in boiler operation? The three different elements concerned are: first, the type of fuel used; second, the firing efficiency, and third, the design and equipment. In these times we cannot complain about the kind of fuel. The fuel is very inferior, but it is all we can get. Some New England plants are adapting themselves to the use of the coal they now have to use, and it is a patriotic duty as well as a necessity.

As to firing efficiency and equipment, these are very poor times to go into the market for new boiler equipment. Boiler and heating changes which can be effected in any plant are purely a matter of expediency. In a plant where the boilers were run ordinarily with about 10 per cent carbon dioxide, there was a fuel loss of about 4 to 5 per cent. The boilers were raised about 2 ft. and some arches put in, and they have since maintained continuously 14 per cent carbon dioxide with no trace of unburned gas.

Another element which makes for poor boiler efficiency and which can be easily reduced is leaks and dirty water receptacles. Those are the places to look for trouble when the temperatures are high. The question of air leaks in the boiler setting is another item which of course has received the attention of all. As good an instrument as can be found in the small plant for testing this is a lighted candle passed over the outside of the boiler once a week.

In conclusion, coöperation between management, engineers and firemen is one essential feature in the conservation of fuel. There are hundreds of engineers who are ready and willing to report the conditions under which their fuel is used if they have the proper backing of the management and the available material by which they can interpret the results which they obtained.

R. J. S. Pigott said that the fuel situation had simmered down to a question of boiler operation and better methods of combustion. In this section of the country the best way to insure this is to use the underfeed-stoking method. During the last five or six years the use of this has grown with leaps and bounds, the reason being the much better method of combustion which is obtained. The old feeds on such coal as we now obtain would be even less satisfactory. As an instance of what the difference is, Mr. Pigott said he knew of a station that changed to underfeeds on some boilers and whose coal factor dropped 12 per cent as soon as the change was made. The station was one of the best-operated ones in the country, but it could not compete with the underfeed.

Two of the principal features of the system are that there is a proper mixture of air and a higher temperature during the period of combustion. The air is blown through the fire so it has a chance to mix with the gas on its way to the surface of the fire, and the lumps of coal act as a mixer. Then in its further passage it maintains a higher temperature while combustion is going on, and the use of equipment resolves itself into a matter of extensions, and the only way we can put in suitable equipment now is to put in extensions. We must turn to the underfeed stoker, and for industrials, at least, great consideration should be given to turbines and making use of low-pressure steam instead of high-pressure. There is no engineering excuse for the use of high-pressure steam in power plants such as we find all over the New England states. Most of our operations could be carried on with low-pressure plants as well as with high-pressure plants.

We find operation after operation run on high-pressure that can very well be put on low-pressure steam. We find dry kilns and other operations allowed to run over the Saturday and Sunday rest periods, thus wasting the steam. In one plant in Bridgeport the over-pressure load on Sunday is maintained and wasted. The use of steam in other connections can be made equally wasteful. The use of steam engines in shops should be discouraged; it is much better to develop all the power in a central station than to have the engines scattered all over the shop.

A. J. German believed that at very slight expense coal can be burned more economically in a furnace by sloping the brick wall of the furnace instead of having it straight. By having the wall straight it becomes very hot, and all the gases that are coming up, instead of having a free passage, strike the wall and ignite. The condition of the combustion can be improved very simply in this manner.

Another way of saving coal is to try to find the number of boilers that can most economically carry the various loads. Take a factory load that is fairly constant during the day and is less constant at night. There are a number of boilers in the factory, and the question is, How many are the most economical? That must be found out by testing the whole plant, and the best thing to do is to start with the full number of boilers and cut down one boiler, then run through the week and average the coal used. Then cut down another boiler, and so on, until the number you can run most economically to carry the varying load is found.

T. W. Russell, State Conservator of Coal for Connecticut, said that every communication from Washington on the general situation is to the effect that there will be enough coal to go around provided the maximum possible amount is mined, and then the largest possible efforts made in the way of economy and efficiency. Here at this end of the line there is nothing we can do to increase the production at the mines. The increase at the mines is rather sharply fixed by the physical limitation of the number of coal cars, and the underlying cause of possible fuel trouble in this country is the physical shortage of coal cars. Therefore it seems at this end of the line we must devote our efforts toward securing more equal distribution of coal, and that the greatest efforts and most fruitful efforts can be put in along the line of increasing the efficiency of every pound burned.

Mr. Russell agreed heartily with the suggestion made by Professor Breckenridge that committees be appointed from the Section to work toward the increasing of efficiency. The state administration office has given considerable time to this question. It has almost completed the appointments for the state committee on coal conservation under the chairmanship of Mr. Charles G. Bell.

The Connecticut Section can do much during the coming months. The poor coal dealers have been filling out blanks much more than they have been endorsing checks during the

past two months. The Federal Trade Commission has made a survey in order to get a number of facts from each of the coal dealers. But in our work there is, unfortunately, an absolute necessity for us to come back to these men for almost the same information they have already given to the Commission. This information is buried away in Washington so far as any immediate availability for us is concerned, and it is very much quicker to write to Mr. Pigott at Bridgeport than to write to the Federal Trade Commission for it. I hope it may be possible to unify matters so that there will be no duplication of work.

The coördination of work should be considered very seriously. There are a number of organizations that are interested and are working more or less independently, but we must not have too many committees and too many blanks to do good work. Instead of having a local committee of The American Society of Mechanical Engineers in New Haven and a local committee of the Chamber of Commerce, and possibly a few other local committees, it would be more logical and more efficient to have all the work coördinated.

FUEL CONSERVATION BY THE BUREAU OF MINES

By O. P. HOOD,[1] PITTSBURGH, PA.

Member of the Society

(Abstract of address)

I HAVE been asked to speak about the Bureau of Mines and what it is doing for the conservation of coal. The function of the Bureau is not always understood. We have certain limitations—as far as the fuel of the Bureau of Mines goes, we are limited to the fuels belonging to or for the use of the United States Government. Instead of being a research laboratory for the general public, we must perform that function indirectly. The work of the Bureau of Mines is primarily for Uncle Sam, himself a fuel user. As a user of something like eight million dollars' worth of coal a year in normal times, the Government has a somewhat varied fuel problem.

At the beginning of the war our director asked me what the Bureau could do to adapt itself to the particular situation. Was there a new gospel to be preached? Was there something new and startling that ought to be brought out? My reply was that it was the same old gospel that had to be preached, that it was only a question of different values and different emphasis, but that our problems were exactly the same problems that we had been working on for years.

The Bureau is taking the stand just at present, as every engineer would, that this is not the time to try new experiments, and to look for relief from some new invention, or from some new way of doing things, but we must draw on the well-known and well-tried methods. If each one of us operating a power plant or having anything to do with the fuel problem would do as well as we know how to do without any further instruction, without any more technical information, we could save about ten per cent of our fuel. Perhaps we cannot save that a year from now. People are getting busy; the higher price of coal has forced them to take this gospel more seriously than they have before, and so the problems of the Bureau of Mines are not so essentially different in these war times.

Formerly we were trying to make war on waste, trying to find out the fundamental principles involved in the use of coal and to get people to believe that what we found out was so. The emphasis, however, of the work has been greatly changed. The Bureau believes, or has believed, that educational methods were in the long run the sure methods. There is a growing sentiment which comes to the ears of the Bureau from a great many directions that under the present condition of things some power must be used. It is only a veiled reference to the "big stick." It seems manifestly unjust, if we are to be limited in fuel, that in the same industry two plants, one of which is using its coal inefficiently and the other efficiently, should be treated in exactly the same way and given the same amount of coal. It seems as though there should be some distinction. It would mean going into the plants and finding out the facts. We who have tried to find out facts about a very simple plant know what it costs, know what a tremendous job it is, and how poorly equipped most plants are to give out facts with regard to their coal consumption. The educational processes are of immediate value, at any rate, although they may not be the only means which may have to be applied. These processes must be speeded up; they must be carried on with a magnitude which we have never conceived of before.

General publicity and the creation of an atmosphere which will be favorable to fuel economy, rather than against it, will help in that it will apply to about 20 per cent of the coal mined, and about 20 per cent of the coal is domestic coal. We must influence about twenty million people in order to save a piece of that 20 per cent. Suppose that they could save 10 per cent of it, that means 10 per cent of 20 per cent, which is, roughly, 2 per cent of the whole. To interest that twenty million people means publicity, placards, advertising, and all of the methods the Food Administration employed, for example.

About 63 per cent of the coal mined is used for producing steam. It is used by probably a quarter of a million firemen, and if we could influence and train that quarter of a million men to do their best, we would be doing a valuable thing. In order to reach that quarter of a million firemen who have the coal on their shovels, educational methods on a large scale must be used again. Like all good teaching, this cannot be done by correspondence-school methods, and at long range. It cannot be done by talking about fuel economy as an art. It is a practice. You may read about the fundamental principles on which it is based, but ultimately you must be taught by the hand, and taught at the furnace in just the same way that blacksmithing is taught at the anvil.

The particular work of the Bureau perhaps can be divided into three main headings. There is the purely research work, the attempt to find out things which we did not know before. For that purpose laboratories have been provided. The work has been going on for a good many years, but it is not going on as vigorously today as we could wish. The Bureau is faced with exactly the same conditions that every employer of labor is facing. We are losing our men, we are breaking in new men, and we no sooner get them broken in than they leave us to go to somebody else, and the solution of our problem is thus interfered with. Above all, the Bureau is adapting itself to the new problems which are being presented to it because of the exigencies of the war. A new plant is just being completed in Pittsburgh, and it represents in round numbers about a million dollars. The plant is given up very largely to fuel work, and it is the exponent of the fuel end of the Bureau of Mines.

Another line of work in the Bureau is the purchasing of coal under contract. The Bureau is known to a great many through this activity more than any other, perhaps, in that

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the Bureau has stood for the purchase of coal on specifications drawn on the basis of B.t.u. It is almost needless to say that under the present conditions the contract has gone glimmering. We no longer think of B.t.u.—we have gracefully retired for the time being, but we will come back stronger than ever when this trouble is over. Fundamentally, the basis is right, but the country is faced with a situation which we have had only once before: namely, we have a sellers' market instead of a buyers' market, and it is only a buyers' market that can talk about B.t.u.

I looked at an analysis the day before yesterday of coal delivered to a Government building. It had 26 per cent ash and 23 per cent moisture. Of course, we realize that the pressure to increase the quantity of coal mined has been severe, and that in the speeding-up process anything black has been called coal. Coals which run around 8 per cent in ash in normal times are now running in the neighborhood of 12 to 15 per cent in ash, and if that extra 5, 6 or 7 per cent ash in the coal applies to all of the coal mined, it means that the apparent increased production in coal is not an increase in coal, but an increase in ash.

Professor Breckenridge's experiments at the St. Louis Exposition seemed to show that in the coals used out there, for every 1 per cent of ash increase in the coal the efficiency of the good coal was reduced about 1½ per cent. There is no absolute figure for that—it will vary anywhere up to 2 or 3 per cent. But suppose there is 7 per cent increase in ash and 10½ per cent decrease in efficiency due to the ash, it can easily be seen what that means to the coal problem.

It can be seen that when one of the great central-station managers made the statement that to produce the same effect his plant was compelled to burn something like 20 per cent more of the stuff they were delivering as coal than they used to burn, it is a serious thing.

Our mining people are beginning to realize this, and they are going to do better. The miner himself has not realized that he was tying up a good many coal cars to haul ash, and that many of his efforts were vain in giving us that stuff.

There is another phase of the Bureau's work. The fuel work of the Bureau was intended to apply to coals belonging to or for the use of the United States Government. We are well aware that if they have any gospel to preach we ought to practise it at home or in our own plants. In the Government plants in general there should be some reasonably high degree of efficiency. There are a number of Government organizations that are very efficient in their steam practice, among them the Navy and Treasury Departments. But there are some organizations of the Government that treat the coal problem just the same as they would the wrapping-paper problem. Coal was cheap, of course it had to be bought, and there was little or no strong organization at the head of the engineering side.

The Bureau of Mines acts as a consulting engineer to the other Government bureaus when they call on us for help in that way. That keeps a number of men busy. For example, over a year ago the Assistant Secretary of the Interior, who had the Bureau of Mines as part of his charge, came to the conclusion that it was not a wise and economical thing to send anthracite coal to Montana, Idaho, Colorado and New Mexico in order to heat the Indian schools; that most people who live out there had to burn local fuels, and he could not see why the Indian schools could not do the same thing. Blanket orders were issued that no anthracite coal was to go west of the Mississippi or north of Kansas. It was proved conclusively that they could not keep a fire over night unless they had anthracite coal. The Bureau had never thought before of trying to contradict this, but now we bought an ordinary hot-blast stove. We had small supplies of coal from all over the world there at the plant, and we proceeded to prove, to ourselves, at any rate, just what kind of a heat curve we could get if we would learn how to use that ordinary hot-blast stove, which we could recommend to an Indian school. I cannot reproduce the curve for you, but you will be interested to know that it is not so very much of a trick to learn how to use those western coals from North Dakota and Wyoming so they can keep a fire just as well as you can in an anthracite burner. Further than that, one can get a temperature curve from the heating surface of the stove that compares very well with anthracite burners. In other words, the Bureau knows that it is just a matter of knowing how.

The Bureau of Mines has to do with the conservation of its own fuel and its own plants for the Government service. Lately there has been a change in accent in the Bureau's work. It was perfectly evident that this was the psychological moment for the propagation of right doctrines; that this was the time when fuel problems must be discussed on a sound physical and economical basis. The air is full of fuel fallacies. As an illustration, I was in Tennessee about a month ago looking over a number of plants there, and I ran across a number of instances where they were following the fallacy that what you need is to get the fire up close to the boiler so it will absorb heat. What was the use of having the boiler way off from the flames? They wanted the flames to hug the boiler!

In all this work there is going to be a large amount of publicity on fuel matters which will help to eliminate the most glaring of the fuel fallacies and will educate the public in the proper facts of the matter.

Just what can the Bureau do in publicity work at this time? It is limited in its funds and it cannot send out literature broadcast. If one wants anything the Bureau has, one must write and ask for it, and can have just one copy. Now it is evident that we cannot carry on a great fuel propaganda under such circumstances.

A number of organizations in Washington believe it is their duty to feature fuel propaganda. It is perfectly natural, perhaps, to expect that the Fuel Administration should do that, and almost equally evident that the Bureau of Mines should do something of the sort. The Geological Survey has been doing something of the sort for years in its particular field, and so has the Chamber of Commerce. The Food Administration is in the fuel game for perfectly good reasons. The Department of Agriculture in its domestic-economy work, which applies directly to the farmer's wife, is considering the question.

In this time of stress the engineering societies ought to do something in this field. The members of these societies have the technical information to give that will set the thing going correctly. It is desirable that in some way the technical information given out shall be consistent. It is not desirable to have anything advocated in one way in one place and another way in some other place. The proper function of the Bureau of Mines at this time is to try to influence the sources of information to publish fuel propaganda; to act as consulting engineers to any of these organizations that we can induce to let us see their manuscripts.

It would be presumptuous for the Bureau of Mines and its limited staff of engineers to perform this function alone. We want the backing and we want to be able to reflect the knowledge and good judgment of the engineers of the country, and so there has been appointed by the Engineering Council

a committee from the engineering societies to act as controlling engineers to the Bureau of Mines in helping to guide the technical information which is being disseminated.

DISCUSSION

E. H. LOCKWOOD related some experiments he had made in his laboratory on keeping the doors of the boiler open and seeing what effect this had on the temperature of gases leaving the boiler.

In making some tests with a small boiler, he found that when he closed the grates in the door he got a certain temperature, and when he opened the grates ⅛ in. the thermometer went up 10 to 15 deg., which implied that air coming in the front door made a hotter fire. He opened the grates still wider, and the thermometer began to go down, and it was perfectly plain that in order to get a maximum temperature he had to move the grates in the door open a certain amount.

C. H. BROMLEY said that the engineers have been preaching and learning how to save coal for many years, and yet they know nothing about burning coal economically! The magnitude of the waste must be brought home now with sufficient force to make us do what we already know how to do. That is the chief problem, and is the reason for wide publicity that will move men to do what they know how to do.

Any man who knows steam-boiler work knows that 20 per cent of the coal burnt under them is wasted. That is a very conservative estimate; we could say more accurately that the avoidable loss in steam production is 35 per cent to 40 per cent. But to be conservative call it 20 per cent, and we have a loss of 45,000,000 tons avoidable waste per annum. Reducing the figure to $5 a ton, we get an average figure of $225,000,000 as the money loss per annum.

Another serious loss that occurs in boiler operation is due to the design of the stoker. The stoker has been brought to a very fine state of perfection, but unfortunately no stoker builder has incorporated in his particular stoker the two features necessary to make his machine perfect commercially. The losses due to the combustion in the ash are running now, in the average well-conducted plant, from 20 per cent to 50 per cent. Some stokers have air admission to the dump plate, many of them have not; some have clinker breakers at the clinker or dump grate to break up the clinkers with the air admitted in the fire bed of the stoker. What is wanted is a combination of air orifices or openings that will not clog up, and through which air will be admitted directly to the clinker as it is formed, so that we may burn the carbon up. It was estimated several years ago that Germany was losing approximately 4,000,000 tons of combustible a year due to losses in the ashpit. Our loss in that respect is running very close to 8,500,000 tons of combustible. These are staggering figures, such as we need to stimulate us to action. That 45,000,000 tons, which may be taken as fair waste, means not only money loss, but it means tying up approximately 900,000 fifty-ton cars, a very serious thing.

In the Rainey resolution introduced before Congress in May 1917, it was alleged that over 200,000,000 tons of coal a year are wasted in mining. The eight-hour day granted in May 1916 is responsible for that loss in production. It has amounted in five months in the anthracite industry to over two million tons of coal, and if you look for the anthracite mines on the coal map you can find them. The big problem seems to be at the present time to learn how to burn lower grades of fuel. That must be done through stokers or through better coal. We will have to be moved to action by startling figures so that we may do what we know how to do.

INDUSTRIAL PRODUCTION

A Few of the Elementary Principles of Increasing Production and Decreasing Cost in a Medium-Sized Manufacturing Plant, and at the Same Time Promoting the Welfare of the Employee

BY WILLIAM M. DOLLAR, BUFFALO, N. Y.

Member of the Society

ANY scheme of industrial production to be efficient must embody, among others, the following points:

1 The proper purchasing of the proper raw materials
2 The storing of this material so that it will be safe and accessible
3 The rapid and economical transfer of material from the stock room to the factory as needed
4 The progress of material from machine to machine and department to department with a minimum of handling and without congestion
5 The maintenance of a proper system of inspection of work in progress
6 Forms, transfer cards, etc., that require nothing in filling in but the ability to read and make legible figures
7 The handling of time cards first by a man familiar with shop details
8 Remuneration that will bring out the workman's best efforts in regard to quality and quantity of output.

Abstract of paper presented before the Engineering Society of Buffalo, October 31, 1917.

PURCHASE OF RAW MATERIALS

The proper purchasing of the proper raw materials is a commercial matter. It means buying the right quantity at the right time and at the right price, and is largely a matter of judgment which almost amounts to instinct in some men. Regarding quantity, the man who buys should be in close touch with both the sales and the production ends of the business. Buying a large supply of a certain raw material at a low price is of absolutely no advantage if the interest on the money required to make the purchase offsets the saving before the material is used up.

Proper raw materials should be specified by the production or engineering department; many a 2 per cent off has developed into 10 per cent *on* because the goods were not proper for the use to which they were to be put, and the purchasing

agent will usually benefit by taking the advice of the man in the shop, since three times out of four the latter will be right.

Storing Raw Materials

The arrangement of the raw-stock room must be such as to require a minimum of effort both in getting the goods in and passing them out as required. The specific arrangement and construction of the various bins and racks depend on the character and quantity of the goods, and these in turn on the requirements of the business. Only the most general rules can be laid down, as the details of each store room must be worked out to suit the particular case. Accessibility, visibility and cleanliness are important points to keep in mind, and no sacrifice of these should be permitted. A stock room is built but once, but is used every day for years, and the manufacturer can well afford to spend whatever may be necessary to get the best and most economical arrangement and construction.

Equally important is some method by which the stock man can tell at once the exact quantity of a given material on hand, and this, too, with the least labor, clerical or otherwise. One of the easiest ways to accomplish this is by means of a card index consisting of the standard 3-in. by 5-in. cards, with columns for "Date," "In," "Out" and "On Hand," respectively.

The Moving of Material

The rapid and economical transfer of material from the stock room to the factory as needed is emphatically a problem that must be worked out according to the conditions. How the material is handled, whether loose, in bundles, barrels, tote boxes or singly; and whether transported on barrows, trucks, motor trucks, hand trolleys, monorail or traveling crane, depends on the material and the character of the buildings. The less man power used, particularly under present conditions, the better.

The progress of the material from machine to machine and department to department must be effected with a minimum of handling and without congestion. All movements of material should be in one direction, and in as nearly straight lines as possible, from the raw-stock room to the assembling floor, the finished-store room, or the shipping department, whichever its ultimate destination may be. Means should be provided to trace the progress of all material through the factory so that just what progress is being made may be known and the responsibility fixed for any delay.

Inspection of Work in Progress

A proper system of inspection of work in progress must be maintained, as it insures against unnecessary labor on spoiled or defective parts, and also permits steps to be taken at once for the replacement of these parts and avoids delay in the final assembling.

It is not always, or even usually, necessary to maintain an inspection department for this work. Each operator can inspect the work done when the part comes to him, and if it is made to his interest to do so, and to his detriment not to do so, the inspection will be even better done than by the class of help found attached to many inspection departments.

In one instance that comes to mind, where the product was particularly well adapted to piece work, the management hesitated to install it on account of the cost of the inspection. A system of bonuses for the detection of errors and fines for failure to detect them was worked out, with the result that not only was the quantity of the output largely increased but also its quality, while the cost was very materially lowered—and this with all the inspection done by the regular machine hands and assemblers.

Simple Forms Desirable

Nothing beyond the ability to read and make legible figures should be required in filling out forms, transfer cards, etc. Shop men are not bookkeepers, and they usually resent all attempts to make them such. Where conditions are right, some form of time stamp can be used to record the beginning and ending of a given operation; if this method is not practical cards can be so designed that all the workmen has to do is to record the exact start and finish time.

Whatever form these records take they must be used as the foundation not only on which costs are built but also on which the payroll is made up. The workman is not interested in costs but he is vitally interested in the payroll, and if he is obliged to give correct data for compiling costs in order to insure the correct amount in his pay envelope, he will be very careful in filling out his time cards.

Time cards on reaching the office should go first to some one who is familiar with shop details. While the correct number of hours may appear on the card, the time may not be charged to the right job. The man who first handles these cards should be so familiar with the shop that he can not only judge whether the time has been charged to the proper order, but also whether the time so charged is reasonable for the work done. If he is in doubt the card or cards can be at once returned to the shop for correction while the matter is fresh in the minds of the foreman and the workman. This will avoid the recording of incorrect data. Millions have been spent in the shops of this country in the last twenty years by laboriously recording erroneous cost data, because the man who made the record did not know whether the data were correct or not.

While the recording of cost data is a clerical job and properly belongs to the accounting department, the collecting of cost data is an engineering job and must be done by men trained in the practical work of the shop; men who can tell at a glance whether the particular work specified was performed on a given piece, and whether the time alleged to have been so spent is reasonable for the work done.

Erroneous costs, like erroneous drawings, are worse than useless. Not only is the time spent in their preparation wasted, but they lead astray men who without them would usually come out all right by the exercise of their own common sense.

Remuneration Should be Measured by Output

The remuneration received by the workmen must be such as will bring out the best there is in him both as to quantity and quality of his output. I sometimes think that the whole scheme of remunerating human effort is wrong. We pay by the hour, the day, the week, and occasionally by the year. What we are attempting to get is the product. Why pay this man so much for a hour of his time when what you really want is inlet valves, or that man so much for a day of his time when what you want, and all you want from him, is camshafts?

While human nature is as it is, the paying of so much money for so much time will only result in an effort on the part of the employer to get as much as possible for as little money as

possible, and on the part of the employee to get as much money as he can for the smallest possible output. While the workman is taught that the wealth of the world is the result of his labor, he has not been taught that if he shirks his task he detracts just so much from that wealth and consequently from his share of it, so that in the end his shortcomings come back on himself.

What we all need to bring out the best there is in us, is incentive. Under the time-wage system there is no incentive for any man to do more than is sufficient to keep the boss off of his back and hold his job. To those who are troubled with this problem, and with the prevailing idea of making work for as many men as possible, a very potent remedy is an opportunity for the man to add a dollar or two to his weekly earnings in return for a little extra effort. Get away from the idea that there should be a limit to what a man may earn in a given trade. Let the workman understand that you require output. The more pieces he finishes, the lower your cost. If he doubles his output, as he can and will in many cases, your cost per piece is much less, as you have twice the output with practically the same overhead.

How to accomplish this is a matter each manager must settle for himself. There are innumerable schemes under all sorts of names. Whether you use straight piece work, differential piece work, the premium plan, a bonus system or what not, depends on your conditions. While there may be no best system, generally speaking, there is always a best system for each individual plant. There should be no antagonism between employer and employee, their interests should be identical—namely, to add the greatest possible amount to the wealth of the world in order that they may have the greatest possible comfort and enjoyment of it.

To get the best of competitors, make the pay and the working conditions in your plant better than those in any other plant in your line. Get the good men, give them a chance to earn all they can on some equitable plan, and they will do the rest. When you set a price for a piece of work, be sure that the price is just, and then stick to it no matter what the earnings may be. Much of our trouble, and much of the antagonism shown by labor organizations to all forms of piece-rate and profit-sharing payment for labor, is the direct result of improper rates, fixed through lack of knowledge of what can be done, and lack of moral courage on the part of the employer to stand the consequences of a situation brought about by his own ignorance or carelessness.

PLANNING, ROUTING, ETC.

So far we have been considering only what is applicable to the small and medium-sized shop, which, in the aggregate, covers a large percentage of the total production. The large shop is in a position to go very much farther along the lines of planning and routing than the small concern can.

There is one best way to do every job in a given shop. There is one best machine for the operation, one best sequence of operations, and one best tool and cutting speed and feed to use. If the material is purchased on rigid specifications, so that it comes uniform, it is perfectly practical to have a planning department which will give to the shop the sequence of operations, the machine to be used for each operation, the cutting tool to be used, and the speed and feed under which it shall be operated.

In the small shop, whether it operates its own foundry or buys its castings from a jobbing foundry, the castings do not usually come of such uniform texture as to make this planning practical. The most feasible plan in a shop of this size is to have the foreman do the routing, and put the entire sequence of operations, together with the character of the tools, speeds and feeds, in his charge. With a competent man having the necessary data in charge of the routing, and material of uniform texture, very satisfactory results can be obtained.

The machine shops of the country owe a deep debt of gratitude to the late Fred W. Taylor and his associates for their work along these lines. Mr. Taylor's paper before the A. S. M. E. on the Art of Cutting Metals is a fitting companion to his former paper on A Differential Piece Rate. The only trouble is that neither of them is applicable in its entirety to any shop, and their introduction into a given shop must be in the hands of men who will select only the part which is practical in that shop. While the modern tool room and the idea of having all tool grinding done in the tool room and not by the individual workmen is the proper thing in the larger shops, it is not practical in a large majority of the small and medium-sized institutions. The solution of the problem in the smaller shop is competent supervision.

It should be the principal duty of the department foreman to see that proper feeds and speeds and proper cutting tools are used on every job. In many shops the foreman is expected to do routine work himself. Any man who is competent to act as foreman, and has charge of more than five or six men, can be of more value to the firm if he spends his entire time in the direction of the others. He should have his finger on every man all the time, and do for his gang just what the planning and routing department would do. If he is the right man for the job he can do this better than any centralized department, because unexpected complications are bound to arise which a competent foreman can straighten out immediately.

JIGS AND FIXTURES

Just how far any shop can afford to go and how much money it can spend for jigs and fixtures depends on the class and character of its work. On standard manufacturing, proper jigs and fixtures will permit the work to be done with practically unskilled labor, and the modern tendency is to make machine hands and not machinists—the employer has probably gone entirely too far in this direction. With proper jigs and fixtures and a proper tool-room equipment, any man of ordinary intelligence can soon be taught to perform a certain operation or operations so that his output is all that could be accomplished by the most expert machinist. There has been altogether too much of a tendency to consider the operator as simply an attachment to the machine. The idea is that once a green man has been broken in to perform certain operations, he can earn a fair wage on these operations though he be almost worthless on any other job. This is a shortsighted policy and the machine shops today are suffering from it. The workman feels that he is simply a part of the machine. In order to earn a living wage he must stick to the little job which he has been taught to perform, and he resents the treatment. A dissatisfied employee is never profitable, and the sooner the employers wake up to this fact the better for all concerned.

While it is true that this is an age of specialists, is it not also true that before a man can be a specialist on one phase of a given occupation he must first have a good general knowledge of that occupation as a whole? Is it logical to expect to make a specialist on the cylinder-boring machine who has no knowledge of the rest of the machine trade? A man may be an expert in doing a certain thing so long as the conditions are

uniform, but the moment he is confronted with some unusual condition he must fall back on his general knowledge. In machine work, as in every other line, the larger a man's general knowledge of the business, the more expert he will become in some special branch.

The above is a brief statement of the principles upon which successful industrial production is based. Although most of them are self-evident, there is danger of losing sight of them in these days of abnormal conditions. To obviate this danger it might be well to append the following heresies:

a The shortening of the working day has been one of the most serious drawbacks in the effort toward increased production and lower cost. It has been detrimental alike to employer and employee.

b None of us can produce enough in eight hours to enable us to live as we want to live and enjoy the luxuries we have grown to consider necessities.

c American supremacy in manufacturing has come largely through ability to judge what was good enough for the job. Those who waste time and money trying to find whether a given job cost $9.42 or $9.47 fail to realize that all costs are only a more or less close approximation, and that the same job can never be duplicated at exactly the same cost.

d Our whole scheme of making machine hands is wrong, and unless we get busy and revive the almost extinct species called "general machinists" we are going to lose out in the race for mechanical supremacy.

e In spite of our boasted ingenuity, our present enemies had us beaten mechanically because they trained men for the job for which they were best fitted. Unless they are all killed off or we change our ways they will do it again. You cannot make a superintendent out of a man who has only the capacity of a gang boss.

f We must get away from the fads now in vogue, and must employ men to fit the job.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

The Crippled Soldier

TO THE EDITOR:

"Though far apart, we're one at heart,
In the homelands of the free."

It is for the second reason that I wish I could have been present to listen to and discuss in person the interesting paper on the crippled soldier read by any old friend, Major Frank B. Gilbreth, E. R. C.

For the past 1000 days or more we in England have suffered in spirit with the maimed heroes back from the front, and have had daily ocular proof of the urgent necessity of supporting any movement to make them, where possible, healthy, happy and productive citizens again.

Much has been done, but plenty of scope still exists for the engineer, the scientist and others to exercise their talents in devising improved methods and channels to assist the ever-growing army of sufferers, whether victims of the war or of industry, and I hope that all classes of society in the allied countries will enter heart and soul into the campaign.

In Europe, where scientific management and motion study have not yet made the headway we could wish, its teachings being unknown to the majority, greater difficulty in establishing Major Gilbreth's recommendations will be encountered than in the U. S. A., for you have already introduced and are profiting by accurate measurement.

I feel sure, however, that when you have shown what can be done, we shall be glad to avail ourselves of your practical experience and achievements. To instance the prejudice and lack of imagination existing here, I quote from a reply written recently by a Government department whose attention had been drawn to some of Major Gilbreth's instruments of precision:

"Although these matters have obviously considerable interest in appropriate spheres, it is not thought that such apparatus as is described presents sufficient advantages and utility from the point of view of possible assistance to crippled soldiers as to justify any further action being taken in the matter."

The pity of it!

Nevertheless we must not be discouraged, but must keep on hammering away until the rust is dispersed and the true metal appears. We know it is there, and that sooner or later it must be reached, and, as a result, the lot of all cripples made more contented and easier.

JAMES F. BUTTERWORTH.

London, England.

Cooling of Water

TO THE EDITOR:

The curves of cooling efficiency in the paper on The Cooling of Water for Power Plant Purposes, presented by Prof. C. C. Thomas at the Annual Meeting, are of great use in predetermining the size of pond for a given duty. It is questionable, however, if the expression connecting efficiency and temperatures: namely, $E = (T_1 - T_2)/(T_1 - T_w)$, is applicable outside of certain narrow limits of wet-bulb temperatures T_w. Some readings taken recently on a Thomas nozzle in cold weather were as follows:

Temperature of hot water, deg. fahr.	115	91
Temperature of cold water, deg. fahr.	85	68
Temperature of air, deg. fahr.	31	26
Pressure at nozzle, inches of mercury	8	10
Efficiency, per cent	36	35
Character of spray	Fine	Fine

In calculating the efficiency the wet-bulb temperature was assumed equal to the dry-bulb. For the same conditions the chart of Fig. 9 indicates efficiencies from 55 to 65 per cent. In other words, if this chart were used to predict cooling for winter conditions, temperatures of sprayed water would be indicated much lower than those actually obtainable.

This phenomenon can be explained by the fact that cooling by evaporation goes on less readily in cold weather than in

warm. Thus, suppose the air rising through the spray is heated 25 deg. fahr. Then the volume of air required to take up 1 lb. of moisture or "absorb" about 1000 B.t.u. will be as follows:

Air required, cu. ft.	2500	1800	1300	1000	750	600	500
Wet-bulb temp., deg. fahr.	30	40	50	60	70	80	90

In warm weather only one-third to one-fifth as much air is needed to take up the same heat.

This decrease in relative efficiency of cooling was noted some time ago in the analysis of cooling-tower performances. For this purpose a coefficient of heat dissipation was used, equal to the heat units per hour per degree difference of temperature between mean water temperature and wet-bulb temperature per square foot of air-flow area. For the two types of towers the following values were found:

Wet-bulb temperature, deg. fahr.	Coefficient of Heat Dissipation	
	for forced-draft towers	for natural- or chimney-draft towers
−10	500	...
+30	700	...
50	1000	...
60	1250	340
70	1500	...
80	1800	440

In applying empirical formulæ for spray cooling the influence of the season of the year should not be overlooked. The same caution applies when making acceptance tests of cooling ponds or towers.

PAUL A. BANCEL.

New York, N. Y.

Broader Fields of Usefulness for the A.S.M.E. Sections

TO THE EDITOR:

At this time, when the spirit of service is in the air, loyal Americans are looking for opportunities to make their experience and influence felt. It, therefore, seems to come with special fitness that the sectional activities of the A.S.M.E. are being stimulated and encouraged by the adoption of new By-Laws providing for a more comprehensive and progressive plan for the future.

This has been well pointed out by Louis C. Marburg in his address at the last annual meeting in New York, which was published in the March number of THE JOURNAL.

The opportunity afforded by the revised By-Laws for each section to suit its activities to the local needs gives freedom of action which can be of great value in arranging the best program for each locality.

Coöperation between local engineering interests can also be cultivated to advantage through the Sections, and in such matters as standardization, which in most cases affect more than one line of engineering, greater uniformity of action and results more far-reaching in their scope can be attained.

Such coöperation also is of special value in taking up community matters of an engineering character, which, as Mr. Marburg says, should be more and more a feature of the work of engineering organizations, in order that they may hold the place which is due them on account of the importance of their work.

All these reasons, which apply strongly in times of peace, are much accentuated now that we are in the midst of the critical situations arising from the Great War.

LUTHER D. BURLINGAME.

Providence, R. I.

HOW TO JOIN THE ARMY ENGINEERS

During the past three years the best engineering skill of France and Great Britain has been matched against that of the Central Powers, and the same skill is urgently required in the United States Army. Enlistments of experienced technical men in our army, however, are below requirements. While this deficiency is undoubtedly due in part to the high salaries which American firms are paying their employees, it probably is also due to the lack of proper information concerning the engineering branch of the service. Few civilians know that it is possible for them to perform in the Engineering Corps almost exactly the same kind of work in which they are at present engaged.

It is more important to have the right man in the right place in our army, where lives of men are at stake than it is in any business enterprise. The First Replacement Regiment of Engineers was organized at Washington Barracks, D. C., on December 14, 1917, with the express idea of accomplishing this end. This regiment has not only the responsibility of finding men to fill up depleted ranks but it must also fit the men thus obtained to step into the work of trained, efficient and disciplined soldiers.

The preliminary work of the recruit is first a thorough training in military drill, for the engineer soldier must be prepared to lay down his shovel and take up his rifle at any time. Infantry drills gradually give way to engineer work and more specific technical training. The engineer soldiers must know how to tie all the important kinds of knots and lashings, to build spar and truss bridges, to construct revetments, dig trenches, place wire entanglements, construct machine-gun emplacements, build pontoon bridges and to construct roads. They must also know the methods of demolition, sapping and mining. Specialized training in lithography, zincography, surveying, mapping, photography, carpentry, blacksmithing, electricity and machinery will also be given to all of those who are qualified for further training in any of these branches.

The Replacement Regiment will be called upon to furnish men for the following regiments, battalions or companies: Camouflage; Crane Operating and Maintenance; Depot Service; Electrical and Mechanical; Forestry (Saw Mill); Forestry (Auxiliary Road, Camp and Bridge); Gas and Flame Service; General Construction; Mining; Quarrying, Sapper; Searchlight; Supply and Shop; Surveying, Ranging and Map Reproduction; Water Supply.

Every male citizen in the United States who is physically fit, and between the ages of 18 and 21, and 31 and 40, is eligible to join the regiment by voluntary enlistment.

To be assured of assignment, the applicant for enlistment, should write for an application blank to the Commanding Officer, 1st Replacement Regiment Engineers, Room 107, Headquarters Building, Post of Washington Barracks, D. C. If the blank shows the man to be eligible, an enlistment card is filled out and sent to the Recruiting Officer nearest to the applicant's place of residence, with instructions to enlist the man for service in this Regiment. Transportation and meals will be furnished by the Recruiting Officer and the man will be instructed to report at the Post for duty.

WORK OF THE BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in THE JOURNAL, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 175, 185 and 186, as formulated at the meeting of February 20, and approved by the Council on March 15, 1918. In this report, as previously, the names of inquirers have been omitted.

CASE NO. 175

Inquiry: How is the maximum allowable working pressure to be calculated for the radial section of the outside fire-box plate of locomotive boilers where stayed to the firebox sheet?

Reply: There appears to be no rule in the Boiler Code that makes allowance for the supporting power of such curved stayed surfaces. It has been proposed to revise Par. 212 of the Code to read as follows:

212*a* The maximum allowable working pressure for any curved stayed surface subject to internal pressure shall be obtained by the two following methods, and the minimum value obtained shall be used:

First, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays. To this pressure there shall be added the pressure secured by the formula for braced and stayed surfaces given in Par. 199 using 70 for the value of C.

Second, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays. To this pressure there shall be added the pressure corresponding to the strength of the stays for the stresses given in Table 4, each stay being assumed to resist the steam pressure acting on the full area of the external surface supported by the stay.

b The maximum allowable working pressure for a stayed wrapper sheet of a locomotive type boiler shall be determined by the two methods given above and by the method which follows and the minimum value obtained shall be used:

$$P = \frac{11{,}000t \times E}{R - s\Sigma \sin \alpha}$$

in which

α = Angle any crown stay makes with vertical axis of boiler

$\Sigma \sin \alpha$ = Summated value of sin α for all crown stays considered in one transverse plane and on one side of vertical axis of boiler

s = Transverse spacing (in.) of crown stays in crown sheet

E = Minimum efficiency of wrapper sheet through joints or stay holes

t = Thickness of wrapper sheet (in.)

R = Radius of wrapper sheet (in.)

P = Working pressure of boiler, lb. per sq. in.

11,000 = Allowable stress, lb. per sq. in.

c An internal cylindrical furnace which requires staying shall be stayed as a flat surface as indicated in Table 3, except that the pitch may be increased to p_1 as provided in the following formula:

$$p_1 = p\sqrt{\frac{PR}{PR - 250t}}$$

in which p, P, R, and t are the same as in Par. 199.

CASE NO. 185

Inquiry: Where horizontal fire-tube boilers are so set that the lower part of the shell is not exposed to the fire or products of combustion, is it allowable to dispense with through braces as required by Par. 218 of the Boiler Code, and employ tubes at the sides of the manhole in place of such braces?

Reply: In horizontal fire-tube boilers which are set so that the fire or products of combustion do not come in contact with the lower part of the shell, tubes may be used instead of braces at the sides of the manhole as outlined.

CASE NO. 186

Inquiry: What should be the radius of the fillets formed by the flanging of the sheets of domes to drum connections for riveting to the shells of boilers? There does not seem to be any rule in the Boiler Code covering this detail of construction.

Reply: It is the opinion of the Boiler Code Committee that the flanges should be formed with a corner radius, measured on the inside, of at least twice the thickness of the plate for plates 1 in. thick or less, and at least three times the thickness of the plate for plates over 1 in. in thickness.

REVISION OF BOILER CODE

THE Council of the Society directed that a hearing be conducted in accordance with the recommendation in the Boiler Code that a meeting at which all interested parties may be heard be held at least once in two years to make such revisions as may be found desirable in the Code and to modify the Code as the state of the art advances. The first of these meetings was held at the Society's headquarters in New York, December 8 and 9, 1916.

The Council also directed that the proposed revisions in the Boiler Code be published in THE JOURNAL with the request that they be fully and freely discussed, so as to make it possible for any one to suggest changes before the Rules are brought to the final form and presented to the Council for approval. This has been done, and the revisions were presented in the March issue of THE JOURNAL, pp. 234-247, in the form finally proposed for submission to the Council, except as they may be modified by editing without change of sense. Discussions should be mailed to Mr. C. W. Obert, Secretary of the Boiler Code Committee, 29 West 39th Street, New York, N. Y., and they will be presented and acted on by the Boiler Code Committee.

Since the publication of the March issue of THE JOURNAL, however, certain typographical errors have been discovered in the revisions there presented, and corrections of these are published below, together with the modification of Par. 21, which it was stated in the March issue was in the hands of a special Sub-Committee of the Boiler Code Committee on Tube Sizes. The Sub-Committee has now completed its research and investigation, and its recommendation that Par. 21 be replaced by a table of maximum allowable working pressures

for different diameters and gages of tubes has been approved by the Boiler Code Committee.

PAGE 10

PAR. 21. CHANGE PAR. 21 TO READ AS FOLLOWS:

21 *Tubes for Water-Tube Boilers.* The maximum allowable working pressures for tubes used in water tube boilers shall be for the various diameters and gages measured by Birmingham wire gage, as given in Table 2.

TABLE 2 MAXIMUM ALLOWABLE WORKING PRESSURES FOR TUBES FOR WATER-TUBE BOILERS[1]

FOR DIFFERENT DIAMETERS AND GAGES OF TUBES

Outside diam. of tube in inches, *D*	Gage,—B. W. G.												
	17	16	15	14	13	12	11	10	9	8	7	6	5
	t = .058	*t* = .065	*t* = .072	*t* = .083	*t* = .095	*t* = .109	*t* = .120	*t* = .134	*t* = .148	*t* = .165	*t* = .180	*t* = .203	*t* = .220
½	434	686	938	1334	...	...	...	...	...	...	...	...	...
¾	206	374	542	806	1094	...	...	...	...	...	...	...	...
1	...	218	344	542	758	1010	...	...	...	...	...	...	...
1⅛	...	166	278	454	646	870	1046	...	...	...	...	...	...
1¼	...	124	225	383	557	758	916	1118	...	...	...	...	...
1½	...	...	146	278	422	590	722	890	1058	...	...	...	...
1¾	...	...	...	203	326	470	583	727	871	1046	...	...	...
2	...	...	...	146	254	380	479	605	731	884	1019	...	...
2¼	...	...	...	...	198	310	398	510	622	758	878	1062	...
2½	...	...	...	...	153	254	333	434	535	657	765	931	1053
2¾	...	...	...	...	117	208	280	372	464	575	673	824	935
3	...	...	...	...	...	170	236	320	404	506	596	734	836
3¼	...	...	...	...	...	...	199	276	354	448	531	658	752
3½	...	...	...	...	...	...	167	238	310	398	475	594	681
3¾	...	...	...	...	...	...	139	206	273	355	427	537	619
4	...	...	...	...	...	...	...	178	240	317	385	488	565
4½	...	...	...	...	...	...	...	...	186	254	314	406	474
5	...	...	...	...	...	...	...	...	142	204	258	340	402

$$P = \left(\frac{t - 0.039}{D}\right) 18000 - 250$$

Where P = Maximum allowable working pressure, lb. per sq. in.
t = Thickness of tube wall, in.
D = Outside diameter of tube, in.

[1] Maximum allowable working pressures for superheater tubes shall be the same as for boiler tubes.

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PAR. 28. CHANGE THE LIMITS OF TENSILE STRENGTH FOR THE FIREBOX GRADE OF STEEL TO READ AS FOLLOWS:

55,000-65,000

MARCH JOURNAL, P. 237

UNDER PAR. 212*a* CORRECT SIXTH LINE FROM BOTTOM OF PAGE TO READ AS FOLLOWS:

the weakening effect of the holes for the stays. To

MARCH JOURNAL, P. 238

UNDER PAR. 212*b* CORRECT THIRD LINE TO READ AS FOLLOWS:

determined by the two methods given above and by the

CORRECT THE FOURTH LINE UNDER THE FORMULA TO READ AS FOLLOWS:

$\Sigma \sin \alpha$ = Summated value of $\sin \alpha$ for all crown stays considered

CORRECT ELEVENTH LINE UNDER FORMULA TO READ AS FOLLOWS:

t = Thickness of wrapper sheet (in.)

MARCH JOURNAL, P. 238

IN TABLE 4 INSERT IN FIRST COLUMN OPPOSITE *b*, THE FOLLOWING:

8,000

MARCH JOURNAL, P. 241

CORRECT PAR. 286 BY INSERTION OF OMITTED FIRST SENTENCE OF PAR. 286 IN ORIGINAL EDITION OF THE CODE, AS FOLLOWS:

286 A safety valve over 3-in. size, used for pressures greater than 15 lb. per sq. in. gage, shall have a flanged inlet connection.

A number of fundamental laws governing the properties of wood, such as those covering the relations between strength and specific gravity, and between strength and moisture content, are laid down in Bulletin No. 556 just issued by the Department of Agriculture, entitled Mechanical Properties of Woods Grown in the United States, by J. A. Newlin and Thomas R. C. Wilson. In this publication are presented the results of about 130,000 strength tests, probably the largest single series ever run on one material, made by the Forest Products Laboratory of the Forest Service on 126 species of American woods. The laws derived from the tests cover the general relations existing between mechanical and physical properties of each species, and also the general relations existing between these properties irrespective of species.

Society Affairs

Engineering Survey

Society Affairs Section..... Page 317
Engineering Survey Section ..... Page 339
Library Notes and Book Reviews . Page 359

Requirements for Membership

The following extracts from the Constitution of The American Society of Mechanical Engineers give the requirements for membership in the organization. Application for membership should be made on a special form which will be furnished by the Secretary upon application.

C 9 A Member shall be an Engineer or Teacher of Applied Science of thirty-two years of age, or over, and shall have been in the active practice of his profession for at least ten years and in responsible charge of important work for five years, and shall be qualified to design as well as to direct engineering work. Fulfilling the duties of a professor of Engineering who is in charge of a department in a college or school of accepted standing shall be taken as an equivalent to an equal number of years of active practice. Graduation from a school of engineering of recognized standing shall be considered as equivalent to two years of active practice.

C 10 An Associate shall be thirty years of age or over. He need not be an Engineer, but must have been so connected with some branch of Engineering or Science, or the Arts, or Industries, that the Council will consider him qualified to coöperate with Engineers in the advancement of professional knowledge.

C 11 An Associate-Member shall be a professional engineer not less than twenty-seven years of age, who shall have been in the active practice of his profession for at least six years, and who shall have had responsible charge of work as principal or assistant for at least one year. Graduation from a school of engineering of recognized reputation shall be considered as equivalent to two years' active practice.

C 12 A Junior shall be twenty-one years of age or over. He must have had such engineering experience as will enable him to fill a subordinate position in engineering work, or he must be a graduate of an engineering school.

CHANGE OF ADDRESS

.....191....

To the Secretary, Am. Soc. M. E.,
29 West 39th Street, New York City

Please change my entry in the Year Book to:

Print or typewrite if possible

..... Name. ..... Position. ..... Firm name.

..... Street address of firm. ..... City. ..... State.

..... Street address of home. ..... City. ..... State.

Underline the mail address

SERVICE RECORD

..... Name. ..... Rank. ..... Grade.

..... Department, Corps, etc. ..... Company, Regiment, etc.

..... Stationed at

..... Address for mail. ..... City, Fort, Camp, etc. ..... State.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

IT will hearten the membership, I know, to learn more in detail of the extraordinary service being rendered by this Society through its Engineering Resources Committee.

A classification sheet was sent out to every member of the Society and nearly every member has responded. Based on the replies, the following are the statistics secured:

Common-school education	8600
High-school education	8280
Graduate mechanical engineers	5550
Graduate electrical engineers	575
Graduate civil engineers	140
Graduate mining engineers	21
Other degrees	920
Speak and read French	2510
" " " German	2290
" " " Spanish	600
" " " Russian	64
" " " Italian	70
" " " Japanese	31
" " " other languages	490
Traveled extensively in Europe	1360
" " " South America	225
" " " Central America	145
" " " Japan	178
" " " China	102
" " " Korea	21
" " " Canada	640
" " " British Isles	462
" " " other countries	970
Have had military training	3050
" " naval training	230
Now in the service	910
Can devote full time to the service of the United States	4100
Can accept service involving travel	5020
Can report in one week or less	1970
Specialist in the Branch of:	
Aeronautics	310
Automotive engineering	950
Architecture	475
Ballistics	94
Chemical engineering	490
Civil engineering	1260
Electrical engineering	1910
Fire engineering	390
Heating and ventilating	1720
Hydraulic engineering	1200
Management	2850
Marine engineering	610
Mathematics	1080
Mechanical engineering	6540
Metallurgy	430
Metallography	144
Machine-shop practice	3190
Mill engineering	1720
Military engineering	176
Mining engineering	242
Municipal engineering	216
Naval architecture	220
Navigation	138
Patent law	320
Power engineering	1800
Public-utility service	555
Physics	660
Railroad engineering	1190
Safety engineering	735
Welfare work	420
Positions members have held:	
Appraiser	323
Consulting engineer	2440
Construction engineer	2300
Contractor	660
Designer	4050
Draftsman	3820
Editor	225
Erecting engineer	2200
Estimator	1780
Foreman	1420
Industrial engineer	1060
Inspector	1450
Laboratory assistant	515
Manufacturer	1460
Master mechanic	1230
Office executive	2180
Operating engineer	1780
Organizing engineer	960
Production engineer	1290
Publicity engineer	283
Purchasing agent	1050
Rate setter	320
Research engineer	1030
Sales engineer	1610
Sales manager	840
Specification engineer	840
Superintendent	2020
Teacher	1210
Testing engineer	1740
Works manager	1185

To date nearly 3000 names have been furnished to the several Bureaus of the Government and to the industries generally since the beginning of the war. Notwithstanding that this is obviously a "win the war" activity, our lists are invaluable for the industries whether or not those industries may be engaged in war activities. We probably have the most complete list in existence of specialists, together with their attainments, experience, etc.

Any member not having filled out the classification sheet should immediately write and ask that such a sheet be furnished him, as it is of the highest importance that every man should make his services available to his country. Even if one is not free to give all of his time, if he can give a portion of his time or can make special investigation in his own establishment, all of such services can be made available.

The members of the Committee, George J. Foran, Chair-

man, Fred H. Colvin, Henry C. Meyer, Jr., W. Herman Greul, and formerly J. H. Barr and A. D. Blake, until they were transferred to Washington and absorbed in the service of the United States, give personal attention to requests. The Secretary and his staff supplement the work of the Committee, so that the Government and the industries generally get not only the benefit of a list of specialists, but the assistance of the Committee and the staff of the Society in an attempt to select the men best fitted for the particular work. An excess of the number required is always recommended, so that the Government has the opportunity to make a selection from among those given.

Please help by making sure that your name is on this roll, and still further by suggesting the names of any men especially competent in any realm of engineering who are not now members and whose availability for service should be recorded, and we shall be pleased to send them classification blanks, to be filed separately.

CALVIN W. RICE,
Secretary.

COUNCIL NOTES[1]

A MEETING of the Council was held on Friday, February 15, 1918, in the rooms of the Society. The following members were present: Charles T. Main, *President;* R. M. Dixon, *Chairman Finance Committee;* R. H. Fernald, George J. Foran, representing the *Publication Committee;* F. A. Geier, W. F. M. Goss, Ira N. Hollis, John Hunter, F. R. Hutton, D. S. Jacobus, H. de B. Parsons, Charles T. Plunkett, D. Robert Yarnall, Wm. H. Wiley, *Treasurer;* Henry Hess, *Chairman Standardization Committee,* and Calvin W. Rice, *Secretary.*

Nominating Committee. The President announced that the Sections had selected the following names, and that he had had great pleasure in making them his appointments for the Nominating Committee for officers for 1918: L. P. Breckenridge, William P. Caine, Thomas E. Durban, C. F. Hirshfeld and George R. Wadleigh. A full announcement regarding these appointments was published in the March issue of THE JOURNAL.

Power Test Code. In accordance with the vote at the last Council meeting, the President presented a set of rules for the guidance of the Power Test Code Committee and its sub-committees and advisory board, prepared in collaboration with George H. Barrus, Chairman of the Committee.

Engineering Council. It was voted to approve the appointment by the President of Charles Whiting Baker, George J. Foran and D. S. Jacobus to represent this Society on a special Conference Committee of the Engineering Council to consider and report back to the Engineering Council rules for the admission of associate societies.

Society for the Promotion of Industrial Education. In response to the invitation from the Society for the Promotion of Industrial Education, John W. Lieb and R. H. Fernald were appointed honorary vice-presidents to represent the Society at its Philadelphia meeting, February 21 to 23.

National Security League. A. D. Bailey, William B. Jackson and Arthur L. Rice were appointed honorary vice-presidents to represent the Society in response to the invitation of the National Security League at their meeting in Chicago, February 21 to 23.

[1] The March JOURNAL went to press before the February Meeting.

War Activities. It was voted that all committees of the Society having to do with war activities be requested to report each month to the Council.

Library Committee. The Council approved in principle recommendations of the Library Committee that the title of the Library of the Society be transferred to the United Engineering Society. The matter was referred back to the Library Committee to obtain advice of counsel.

Sections Committee. D. Robert Yarnall, Chairman of the Committee on Local Sections, presented a report of recommended procedure for the election of a Nominating Committee, and it was voted to transmit copies of the report to the Committee on Constitution and By-Laws and to every member of the Council for consideration, and report at the next meeting.

Meetings Committee. This committee reported that in consultation with the Worcester Local Committee, the date for the 1918 Spring Meeting of the Society at Worcester, Mass., had been set for June 4 to 7.

War Department, Ordnance. The Secretary reported the receipt of a letter of thanks from the Chief of Ordnance for the coöperation of the Society in securing ordnance officers.

Screw Thread Tolerances. Acting upon a communication of January 23 from the various tap manufacturers, requesting permission to scrutinize that part of the report of the Committee on Tolerances in Screw Thread Fits relating to taps, the report was referred back to the Committee to carry out this request and, should the manufacturers ask for any revision, to give their request due consideration and again submit the report, revised, if necessary, to the Council.

Machine-Shop Practice Committee. The Secretary reported that another way in which the Society was helping in war activities was through the Sub-Committee on Machine Shop Practice, and that in response to a request from the Director of Division Trade Tests, Committee on Classification of Personnel of the Provost Marshal, our committee had met and was assisting the Provost Marshal in the preparation of statements of the requisites in the various machine trades.

Sub-Committee on Protection of Industrial Workers. The following reports from this committee were received and ordered printed in TRANSACTIONS as part of the proceedings of the year 1917:

1 Code of Safety Standards for Elevators
2 Code of Safety Standards for Woodworking Machinery
3 Code of Safety Standards for Industrial Ladders
4 Code of Safety Standards for Power-Transmission Machinery.

Nos. 1 and 2 were presented at the Spring Meeting, 1917, and Nos. 3 and 4 at the Annual Meeting, 1917.

Coöperation and Organization. On account of the assignment to war work of the members of the Committee on Coöperation and Organization, it was voted that this committee be discharged with thanks and the work be referred to the Sub-Committee on Machine Shop Practice.

Electric Welding Society. A request of the Electric Welding Society asking affiliation with this Society was referred to the Boiler Code Committee with instructions to appoint a subcommittee on Electric Welding of the Boiler Code Committee.

Boiler Code Committee. It was voted that the present Committee on Boiler Code be reappointed as the Committee for 1918.

Adjournment was taken to reconvene on March 15, 1918.

CALVIN W. RICE,
Secretary.

United Engineering Society

EXTRACTS FROM PRESIDENT'S ANNUAL REPORT

FOR the year 1917 the noteworthy occurrences are the creation of the Engineering Council, the completion of the addition to the Engineering Societies Building and the occupation by the American Society of Civil Engineers of the space thus provided for it, the addition of 67,000 volumes from the Civil Engineers' Library to the Engineering Societies Library, the election as Director of the Library of Harrison W. Craver, formerly of the Carnegie Library of Pittsburgh, and the election of Alfred Douglas Flinn to serve the United Engineering Society, the Engineering Foundation and Engineering Council jointly as their secretary, with offices in the Engineering Societies Building.

The Engineering Council held its first meeting on June 27, elected Ira N. Hollis chairman and Calvert Townley secretary, and during the year appointed the following committees: Executive, Rules, Finance, Public Affairs, American Engineering Service, and War Committee of Technical Societies. Good work has been done, but the Council has not perfected its organization, and it was not until the close of the year that a definite financial arrangement was made; an appropriation of $16,000 was requested and granted for the term ending October 31, 1918, to be assessed equally upon the four Founder Societies.

In October, the three new stories of the Engineering Societies Building were so far completed that the American Society of Civil Engineers could move into its new quarters, and were wholly completed before the end of the year. The total cost was $302,027.01, the increase over the estimate being caused by the War. The American Society of Civil Engineers held its annual meetings in the building in January, 1917, and its first regular semi-monthly meeting on November 21, since which latter date all the meetings of this society have been held in the new quarters.

On December 7, at a meeting in the Auditorium, the three original Founder Societies and United Engineering Society tendered a welcome to the American Society of Civil Engineers. [An account of this meeting has already b en published in THE JOURNAL.]

In February, 67,000 books and pamphlets from the Civil Engineers' Library, which were not duplicates of books and pamphlets previously in the Engineering Societies Library, were removed from the 57th Street house of the Civil Engineers to the Engineering Societies Building and placed upon stacks in the same arrangement as in the old building. Ownership of this collection of books has been offered by the American Society of Civil Engineers to the United Engineering Society. Similar action has been taken by the American Institute of Mining Engineers and is expected to be taken by the other Founder Societies. Mr Craver began his duties as Director of the Library on April 2.

September 20, 1917, terminated the year for which the Engineering Foundation had appropriated its income and devoted the services of its secretary, Dr. Cary T. Hutchinson, to the establishing of the National Research Council. The Council was organized on September 19, 1916, and during the year accomplished much useful scientific work in coöperation with the Government. Among these achievements may be mentioned advance in the art of submarine detection, location of aircraft by sound, telephoning between airplanes, protection of balloons from ignition by static charges, progress in gas-warfare problems, and the production of optical glass. The National Research Council now acts as the Department of Science and Research of the Council of National Defense. Further interesting details of the work of establishing the National Research Council are contained in a report dated September 20, 1917, which was published in the Proceedings of the Founder Societies. The National Research Council is now wholly supported by the Government and has offices in Washington.

Completion of the first and major portion of the Catskill Mountain water-supply system for New York City was celebrated by the United Engineering Society and the four Founder Societies by a special meeting held in the Auditorium, November 14, attended by about 1100 persons. [An account has already been published in THE JOURNAL.]

During the year the by-laws of United Engineering Society were amended to create the office of Director of the Library and to provide for the creation of the Engineering Council, the former amendment being made in February and the latter in June.

During the summer, the Tax Department of the City of New York placed the Engineering Societies Building on the list of taxable property and referred the claim of United Engineering Society for exemption to the Corporation Counsel. Later it was decided that six of the associate societies in the building did not satisfy the exemption requirements found in Subdivision 7 of Section 4 of the Tax Law, and that consequently the portions of the building occupied by them would be subject to taxation.

At this date the membership of the four Founder Societies is 33,100 and of the associated societies 25,154, so that a total of 58,254 engineers now have headquarters in the Engineering Societies Building.

The real estate now owned by United Engineering Society is valued at $1,947,171.16.

The income of the Society during 1917 was	$55,854.72	
Expenditures totaled	53,791.87	
Gain for the year	2,062.85	
Surplus at the close of 1916	6,053.25	
Total		$8,116.10

Funds for the benefit of the Engineering Societies Library were obtained during 1917 from the following sources:

American Society of Civil Engineers	$4,000.00
American Institute of Mining Engineers	4,000.00
American Society of Mechanical Engineers	4,000.00
American Institute of Electrical Engineers	4,000.00
United Engineering Society	262.35
Income from endowment fund	5,760.42
Gross income from searches	6,556.19
Sales and income	29.40
Total income	$28,605.36

Library expenses were as follows:

Salaries	$16,961.16
Books purchased	1,614.47
Binding	1,393.35
Supplies	1,299.89
Moving Civil Engineers' Library	381.50
Searches, salaries, and miscellaneous	6,759.54
Total	$28,605.36

Funds held by the United Engineering Society were of the following amounts at the end of the fiscal year 1917:

Library endowment fund	$102,559.70
Engineering Foundation fund	203,374.80
General reserve fund	10,000.00
Depreciation and renewal fund	75,037.41
Surplus	8,116.10
Total	$399,088.01

In the report of the Treasurer are many interesting details about the Society's finances, and in the report of the Library Board a full statement of its activities, showing the importance of the work being done.

Mr. Calvin W. Rice resigned as Secretary of the United Engineering Society to take effect at the end of December, and the Society is indebted to him for a year of gratuitous service.

To Mr. Joseph Struthers who has been Treasurer for nine years, and to the members of the Building Committee, especially its Chairman, H. H. Barnes, Jr., the Trustees would express hearty thanks for valuable services.

CHARLES F. RAND,
President, United Engineering Society.

New Officers of Engineering Council

AT the first annual meeting of the Engineering Council, on February 21, J. Parke Channing was elected chairman; Harold W. Buck, first vice-chairman; George F. Swain, second vice-chairman; and Alfred D. Flinn, secretary. The following committees were appointed:

Executive Committee: The chairman, the two vice-chairmen, and David S. Jacobus, Calvert Townley, George J. Foran.

Finance Committee: E. Wilbur Rice, Jr., chairman; Charles F. Loweth, Sydney J. Jennings, David S. Jacobus.

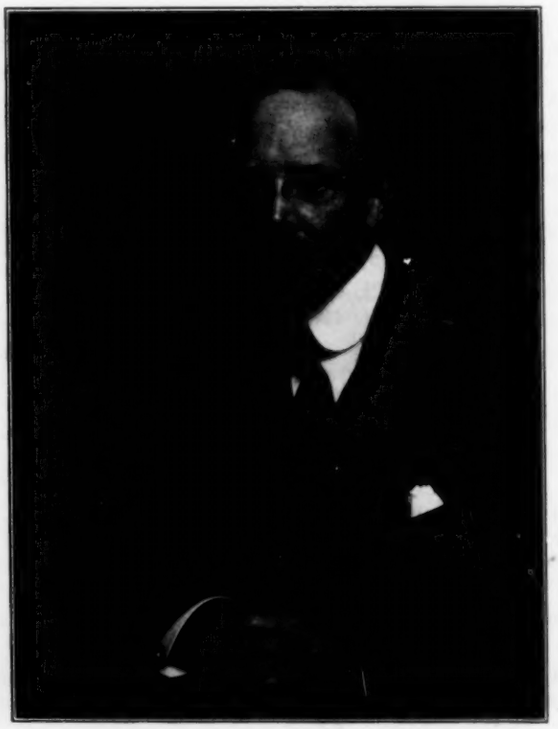
Rules Committee: J. Parke Channing, chairman; Clemens Herschel, Nathaniel A. Carle, Irving E. Moultrop.

Public Affairs Committee: Charles Whiting Baker, chairman; George F. Swain, Benjamin B. Thayer, E. W. Rice, Jr., Charles E. Skinner.

American Engineering Service: George J. Foran, chairman; George C. Stone, Alfred D. Flinn, Dr. Addams S. McAllister, Edward B. Sturgis, secretary.

War Committee of Technical Societies: D. W. Brunton, chairman; Arthur H. Storrs, secretary; James M. Boyle, Nelson P. Lewis (American Society of Civil Engineers), Edmund B. Kirby (American Institute of Mining Engineers), A. A. Greene, Jr., R. N. Inglis (American Society of Mechanical Engineers), Harold W. Buck, Dr. Addams S. McAllister (American Institute of Electrical Engineers), Dana D. Barnum, E. C. Uhlig (American Gas Institute), Joseph Bijur, Dr. Chas. A. Doremus (American Electrochemical Society), Louis B. Marks, Preston S. Millar (Illuminating Engineering Society), Christopher R. Corning, George C. Stone (Mining and Metallurgical Society of America), Henry Torrance, F. E. Matthews, (American Society of Refrigerating Engineers).

Fuel Conservation Committee: L. P. Breckenridge, chairman; Ozni P. Hood, secretary; Robert H. Fernald, Charles R. Richards, Charles L. Edgar, Carl Scholz, David Moffat Myers, Edwin Ludlow, Harold W. Buck.



J. PARKE CHANNING

J. Parke Channing, the newly elected chairman, was born in New York City and was graduated from Columbia University with the degrees of Engineer of Mines and Master of Science. After graduation he was first engaged in mining in the Lake Superior iron and copper region, and later in Montana, Utah and Tennessee. In 1900 he developed and equipped the Tennessee Copper Company, and a few years later built one of the largest sulphuric-acid plants in the world to utilize the waste gases from its copper furnaces. In 1907 he discovered and developed the Miami copper mine in Arizona, now producing copper at the rate of 60,000,000 lb. per year.

For three years Mr. Channing was president of the Mining and Metallurgical Society of America, and is now its vice-president. He was one of the founders of the Lake Superior Mining Institute and is one of its past-presidents. He was directly responsible for the founding of the Michigan College of Mines. He is a member of the American Institute of Mining Engineers and one of its former vice-presidents. He is also a member of the Institute of Mining and Metallurgy, England. He is vice-president of the Miami Copper Company and of the General Development Company.

Dr. Ira N. Hollis, the retiring chairman of the Engineering Council, has given untiring effort to the first year of the Council's existence, with its many problems of organization and the great number and variety of suggestions for usefulness to the Government in connection with the war. In spite of his residence in Worcester, Mass., and his many duties there, he attended all Council meetings and meetings of the executive committee in New York, and made frequent trips to Washington. His enthusiastic devotion to the Engineering Council during the year that he was also President of The American Society of Mechanical Engineers made large demands upon time already heavily mortgaged by his duties as president of the Worcester Polytechnic Institute and by related activities.

SPRING MEETING

WORCESTER, MASS., JUNE 4-7

THE program for the Spring Meeting, an outline of which appears on this page, provides a much-needed opportunity for the engineers of the country to get away from their strenuous war duties, take counsel with each other, and obtain a broader vision of the great undertakings for which they are now responsible. America must supply home demands during the war, without sacrificing the war demands, and she must do this with a gradually diminishing supply of labor. Mass production is required on an enormous scale and machine production must be carried into fields where hand work has formerly prevailed. There must be greater efficiency and economy, greater foresight, more extended research and more careful planning.

In normal times Americans have generally accomplished their results individually in competition with one another and with firms of other countries; but under the stress of the present moment it is necessary to pool our knowledge and to coördinate our work, a result which can be best attained by getting together for an interchange of ideas. It is this function which it is expected that the Spring Meeting will fulfill, and to this end the Committee on Meetings has arranged for a discussion of topics of great industrial importance.

TENTATIVE PROGRAM

TUESDAY, JUNE 4

Afternoon: (Hotel Bancroft)

Registering of Members and Guests at Society Headquarters

Meeting of Research Committee and Flow Meters Sub-Committee

Evening: (Hotel Bancroft)

Addresses of Welcome by Mayor Pehr G. Holmes, Past-President Ira N. Hollis, and R. Sanford Riley, President Worcester Chamber of Commerce

Reception and Dance following the addresses

WEDNESDAY, JUNE 5

NEW ENGLAND DAY

Morning: (Worcester Polytechnic Institute)

Business Meeting

First New England Session:

Papers and addresses contributed by the New England Sections of the A. S. M. E. and the Providence Engineering Society. The topics listed below will be begun at this session and continued in the afternoon

The Growth of an Industrial City, Hon. Charles G. Washburn

The Small Industry and Democracy, Dr. George H. Haynes

The Textile Industry in Relation to the War, J. E. Rousmaniere

Other subjects to be presented are: Changing a Non-essential Industry to Munition Manufacturing; Organizing a Compact Community for the Manufacture of War Material; Fire Protection for Industrial Plants; The Boston Plan for Vocational Training of Enlisted Men; Aeroplane Manufacture; Constructional and Manufacturing Problems in Building Destroyers

Sections Luncheon and Conference

Afternoon: (Hotel Bancroft)

Second New England Session:

General Session with technical papers

Industrial Safety and Workmen's Compensation Session

Tea at Tatnuck Country Club

Evening: (Hotel Bancroft)

General War Session. The general theme of this evening session will be: How the Engineering Societies Can Assist in the Procurement Program of the Government. Some major topics to be discussed are: Ordnance and Ships for the Navy Department; Munitions for the Army; Aircraft Material; Merchant Ships

THURSDAY, JUNE 6

Morning: (Worcester Polytechnic Institute)

General Session with technical papers

Fuel Session (a list of topics follows the program)

Public Relations Session

Afternoon: (Norton Company's Plant)

Luncheon

Paper on Housing Problems

Inspection of the Norton Company's community housing and garden projects

Evening: (Worcester Country Club)

Dinner

Illustrated Lecture: Harvard's Contribution to Astronomy, Dr. S. I. Bailey, of Harvard Observatory

FRIDAY, JUNE 7

Morning:

Automobile Trip to Camp Devens, via Clinton Dam

Lunch at Camp Devens

Afternoon:

Auto Trip to Concord, Lexington and return via the Wayside Inn

New England is probably the largest center of munitions production in the country. Accordingly, a New England Day has been arranged, when the engineers connected with the manufacturing plants of that section engaged upon war work, are asked to present their problems for discussion and to contribute any data which will be of value to others. On the evening of the same day, representatives of several of the governmental departments engaged in the procurement of supplies

for the Army and Navy will give addresses. Another session will be for the discussion of questions incident to Fuel Economy, as outlined in the article which follows, when all who have had to give serious consideration to improved methods for fuel burning during the past winter are asked to contribute the results of their experience for the benefit of the Fuel Administration.

Vocational training for enlisted men, and housing problems incident to war conditions are to be discussed and one session will be devoted to municipal problems of the engineer in war times. There will also be a careful selection of miscellaneous technical papers, so that there may be put on record in the Society Transactions the results of engineering research, in accordance with the usual custom of the Society in conducting its publications.

The Local Sections of New England and the Providence Engineering Society are actively coöperating with the Committee on Meetings in the preparations for the convention. During the first three days simultaneous sessions will be held in order to complete the professional business by Thursday night. This will leave Friday free for a trip by automobile to the cantonment at Camp Devens, Mass., and for a visit to the historic places of Concord and Lexington. Probably most of those who will be present fully appreciate that this part of New England is one of the most beautiful sections of the country for outdoor life, and this trip on Friday, as well as the other social features, has been arranged with a view to the enjoyment of outdoor pleasures to the fullest extent.

FUEL SESSION

SPRING MEETING, WORCESTER, MASS., JUNE 6

On Thursday morning, June 6, there will be a session of the Spring Meeting at the Worcester Polytechnic Institute for five-minute presentations of data relating to fuel economy. This session has been planned by the Fuel Conservation Committee of the Engineering Council to assist the United States Fuel Administrator in his nation-wide campaign for fuel economy. The topics upon which discussion is solicited are listed below and all members of the Society, or others, who have studied the problems incident to the adverse fuel conditions of the past winter are invited to give the results of their experience in the form of brief written communications of from 100 to 1000 words each. In so far as possible, these will be presented at the time of the meeting and later collated for publication and for transmission to Dr. Garfield's department at Washington. Contributions to this session should be mailed to the Secretary of the Society, 29 West 39th Street, New York, not later than May 1.

1 WHAT ARE THE ECONOMIC EFFECTS OF IMPURITIES IN COAL?

Incombustible in fuel has a detrimental effect upon furnace operation out of all proportion to the percentage of refuse contained. It has been claimed that when coal contains 40 per cent of refuse it becomes valueless as fuel. Recent conditions have afforded opportunities for interesting observations in this connection. What has been your experience?

2 TO WHAT EXTENT IS FUEL OIL LIKELY TO BE USED AS A SUBSTITUTE FOR COAL?

Information is desired as to present use, advantage found, probable available supply, etc.

3 HOW CAN SOFT COAL BE BURNED WITHOUT SMOKE IN MARINE BOILERS?

The avoidance of smoke would decrease the radius of visibility of our ocean carriers by many miles and greatly reduce their liability to attack by submarines. If efficiency is improved incidentally it means much more than the mere coal saving.

4 WHAT ARE THE POSSIBILITIES IN THE DIRECTION OF THE UTILIZATION OF ANTHRACITE WASTES?

What success have you had in burning anthracite slack or culm? Do you mix it with soft coal, and in what proportions? What sort of grate do you use and what is your practice with regard to thickness of fire, draft, rate of combustion? Can the mixture be burned in a stoker?

5 WHAT INSTRUMENTS ARE USEFUL AND DESIRABLE IN THE BOILER ROOM AS AIDS IN SAVING COAL?

What class of equipment has been of the most value to you and how?

6 WHAT IS ESSENTIAL TO THE ECONOMICAL OPERATION OF HAND-FIRED BOILER FURNACES WHEN USING SOFT COAL?

Helpful hints as to firing methods, front or side; frequency of firing; management of dampers; cleaning; etc.

7 TO WHAT KINDS OF PLANTS AND COALS ARE THE DIFFERENT TYPES OF MECHANICAL STOKERS RESPECTIVELY ADAPTED, AND WHAT IS THE LIMITING FACTOR TO THEIR USE IN THE SMALL PLANT?

Can we agree upon the type of fuel to the combustion of which each type of stoker is best adapted? How large must a plant be to warrant the use of a mechanical stoker?

8 WHAT EXPERIENCE HAVE YOU HAD IN THE USE OF WOOD AS FUEL? TO WHAT EXTENT IS WOOD AVAILABLE AS A FUEL?

The coal shortage has occasioned the use of wood fuel in many unwonted places. Accounts of experience that will be helpful are solicited.

9 WHAT COAL ECONOMIES CAN BE EFFECTED IN RESIDENCE HEATING?

He who could make one ton of coal do the work of two during the past winter, not only conserved the coal for his neighbor and saved his own money but was comfortable when he might have otherwise been cold. How can it be done?

10 WHAT COAL ECONOMIES CAN BE EFFECTED IN THE SMALL STEAM PLANTS?

Plants which are not sufficiently important departments of their industries to warrant expert supervision and are too small to support real engineers waste a lot of coal and steam in the aggregate. What are the principal sources and methods of waste and how can they be avoided and corrected?

11 WHAT EXPERIENCES HAVE YOU HAD WITH THE STORAGE OF COAL?

12 While the above topics are all that can be suggested for discussion, additional short papers on any fuel topic are desired for publication. Items of interest on fuel performance should be sent to the Secretary. A few additional topics are suggested:

a To what extent and where will the gas producer be used to produce economies?
b To what extent is natural gas being used as a fuel for power purposes?
c What is the relative economy of the locomotive of 1900 and today?
d What proportion of the coke is made in by-product ovens?
e What are new and important developments in methods of burning coal?
f What economies have resulted from recent practice in making brick settings leakless?
g To what extent is coke being used for residence heating?
h Is automatic air supply correctly proportioned to coal supply possible?

John Fritz Medal

On Wednesday, April 17, at 8.30 p. m., there will be held in the auditorium of the Engineering Societies Building, New York, a meeting at which the John Fritz Medal will be publicly presented to J. Waldo Smith, Mem.Am.Soc.M.E., for "Achievements as Engineer in Providing the City of New York with a Supply of Water." Col. John J. Carty, Past-President, American Institute of Electrical Engineers, will preside. The medal will be presented by Ambrose Swasey, Past-President Am.Soc.M.E., and addresses will be given by other speakers.

AMONG THE LOCAL SECTIONS

THE Spring Meeting at Worcester will afford an opportunity for representatives of the Sections to hold a conference. They will meet at luncheon with the Council on Wednesday, June 5, at which time addresses will be made by President Charles T. Main and Dr. Ira N. Hollis. The sessions of the Spring Meeting will be devoted to a large extent to developing ways and means by which the Society can speed up and increase the service which is being patriotically rendered the Government. This Sections Conference will therefore assume proportions almost international in importance, because it is largely through the medium of the Sections that the Society can achieve undertakings of this nature. Several of the Sections have already held meetings which promise to prove of enormous assistance in winning the war. In fact, the dominant note in Sections activities is that nothing is now worth while which does not contribute to this end.

The meeting of the New York Section on non-essential industries, an extended account of which is given in this issue of THE JOURNAL, has aroused more general interest than any meeting held by that Section in years. The press gave considerable space to a report of the meeting, the New York *Evening Post* devoting practically two columns to it. Representatives of a large variety of trades and industries were present and the journals specially devoted to their interests contain full accounts of the discussion. A resolution was passed at the meeting to the effect that the Society organize to develop the use of any of the available equipment and working forces of plants engaged in the manufacture of anything not directly necessary to winning the war. In this way the disturbance to the industries will be minimized, and their plants kept working to capacity.

The Committee on Sections has distributed to the chairman and secretary of each Local Section a record book. This is arranged in loose-leaf style and contains forms for the reporting of meetings, concise statements relative to the By-Laws governing Sections activities, the requirements for membership, and the privileges thereof, and a description of the publications and of the library. There are forms for recording details about the various committees of each Section, a history of the Section, the development of special mailing and telephone lists, a diary for notable events during the year, the development of papers for meetings, a balance sheet, and corrected lists of the personnel of the Council and Sections Committees with their addresses. These record books should help the Sections officers in the organization of their work, and thereby give them more time for the important work of preparing for meetings.

Section Meetings

ATLANTA

February 12. At the invitation of Mr. Robert Gregg the members of the Section participated in a dinner at the Druid Hills Golf Club.

Chairman Elsas gave a report of the conference of Sections delegates at the Annual Meeting. The discussion which followed developed a general feeling that the affiliated technical societies should receive more active support by the local sections of the national engineering societies.

CECIL P. POOLE,
Section Secretary.

BALTIMORE

March 12. At the fourth regular meeting the attendance was the largest on record, and great interest was shown in the discussions presented on canning of foods, as this is one of Maryland's most important industries.

The first paper of the evening, presented by J. H. Shrader, Assistant Physiologist, U. S. Department of Agriculture, outlined the general process of canning, referring particularly to tomatoes, which are the staple product of Maryland. Each process used was described and illustrated, its faults and inefficiencies from a food-utilization viewpoint pointed out, and it was shown that fully 45 per cent of the food value of the tomato as delivered at the plant is wasted in the process. This waste occurs in storage during excessive supply, in poor sorting, in wasteful peeling and in can filling.

The question of the manufacture of "tomato paste" was considered, and as the waste, labor charge and loss in this process is very small, it offers wonderful opportunities for the efficient operation of canning plants. The food value of the product is as high as that of the regular canned goods, while the bulk is tremendously reduced, thus reducing space and freight and providing a cheaper product than the ordinary canned tomato.

Prof. Julian C. Smallwood, Mem.Am.Soc.M.E., who has conducted extensive researches in the use of steam in the canning industry, and is an authority on this subject, presented the second paper, on Economy in the Use of Steam, by means of diagrams. The wastes covering washers, scalders, kettles, exhausters and process kettles, together with radiation were traced in the various steps of the process and the ways and means of elimination were discussed. A plant where losses of this kind were reduced to a minimum was described and it was shown that the boiler hp. necessary could be reduced from 265 to 140, with a corresponding saving of fuel. Experiments showed the ordinary exhauster process is most ineffective in securing the result desired. Great opportunities for economy in the process kettles and the advantage of using low-pressure steam are offered.

The last paper was delivered by J. C. Taliaferro, plant manager, Continental Can Co., on The Filling and Closing of the Modern Can. The problem for engineers is to design a filling machine that will put the required amount, without waste, into each can. The Government requires a certain standard of filling the cans, and canners usually overfill their cans thus making it impossible to exhaust properly and thereby spoiling the contents. When cans are overfilled some liquid must be spilled before exhausting, and this is wasted. Until our engineers can design such equipment we must continue to thus needlessly waste a large proportion of our food products in the process of canning.

A. G. CHRISTIE,
Section Secretary.

BIRMINGHAM

At the February meeting held jointly with the Alabama Technical Association, C. B. Davis, Mem.Am.Soc.M.E., delivered a paper on Fuel Conservation.

March 21. Mr. J. A. Sirnit, of the Alabama Power Co., gave a talk on Water and Fuel Equipment Warrior River Reserve Station. A more detailed account of the meeting will appear in a later issue.

W. LEE ROUECHE,
Section Secretary.

BOSTON

March 16. A subject of the greatest importance and most serious to the American nation at the present time was the address on Man Power delivered by J. Parke Channing. A more detailed account of the meeting will be published in a later issue of THE JOURNAL.

W. G. STARKWEATHER,
Section Secretary.

BUFFALO

February 20. After a trip through the Buffalo High School, Chairman F. E. Cardullo gave a talk on Manual Training, emphasizing its general educational value to the student.

March 6. Under the auspices of the American Chemical Society Section an illustrated lecture on Some Phases of Glass Making was delivered by Dr. E. C. Sullivan, Chief Chemist of the Corning Glass Works. The lecture was extremely interesting as the speaker has done much toward meeting the glass situation in this country since the exports of Germany have been cut off.

March 13. The Hydroelectric Power Problem and the general considerations involved in the exploitation and design of hydroelectric plants, formed the subject of an address by J. A. Johnson. The economic question of the relation between the location of available power and the location of industries was discussed and the speaker traced the advantages and disadvantages in the generation and transmission of power over short and long distances; the value of the steam plant and the economic relations between the two.

March 20. Under the auspices of the S.A.E. Section a paper on Worm Gear Bronze was delivered by W. M. Corse.

March 27. A night of "Mystery" held under the auspices of the A.S.M.E. Section. Details of the meeting not being available at this time, will be published in a later issue.

E. B. NEIL,
Section Secretary.

CHICAGO

March 1. The subject of the meeting was the Coal Situation and was discussed by Joseph Harrington, Mem.Am.Soc.M.E., and Prof. H. H. Stoek, head of the Mining Department, University of Illinois, and also chairman of the Conservation Committee of the Fuel Administration for Illinois. Mr. Harington dealt with one phase of the subject, plant control, and showed how the efficient equipment of a plant and the keen observation on the part of the employees will increase the efficiency of the plant. He emphasized the fact that employers very often fail to grasp the point that while conscientious, intelligent operatives often overcome certain losses by inefficient machinery, it is essential to have the newer type of machinery installed in order to work efficiently. The question of improving plant operation by education or by autocratic overseeing by the Government was also discussed. Mr. Harrington claimed in addition to having educated engineers as operatives it is also necessary to have compulsory measures through Government committees in order to have any practical effect on the consumption of coal of the country.

Prof. Stoek in discussing the coal situation showed the lack of fuel to meet the present demands and advocated restrictions in unnecesary demands.

A. L. RICE,
Section Secretary.

INDIANAPOLIS

January 25. At a joint meeting of the Indiana Engineering Society with the A.S.M.E. and A.I.E.E. Sections which lasted throughout the entire day, the following papers were presented at the morning session: Concrete Roads versus Other Types of Construction, by W. E. Graves, Assistant City Engineer, South Bend, Ind.; Discussion on Roads and Recent Development in Brick Paving, by E. B. Smith, Laporte, Ind.; Indiana Market Highways in War Time, by W. S. Moore, Chairman State Highway Commission; History of an Old Bridge, by J. S. Spiker, Vincennes, Ind.; and Water Bound Gravel Roads, by Karl L. Hanson, Connersville, Ind. Motion pictures showing the construction of buildings and roads at the cantonment at Camp Dodge, Iowa, were presented by C. D. Franks, of the Portland Cement Association.

At the afternoon session Colonel Slaughter, U. S. A., presented a paper on Recent Development in Signaling at the Front, in which he described the use of carrier pigeons, message bearers, sound signaling and radio communication.

Mr. J. F. Gilchrist, Vice-President of the Commonwealth Edison Company of Chicago, delivered a paper on Financial Problems of the Utility in War Times, pointing out that as utility companies generally have an investment of from five to six times their annual gross receipts, whereas in many other lines of business the annual gross receipts and investments are about the same, public utility corporations require large amounts of capital for their operation. This capital has been raised in the past principally by the sale of bonds and preferred stock, for which there is little sale at this time. An estimated sum of $100,000,000 will have to be raised in the year 1918 to take care of the necessary expansion of the public utilities. In past years, a number of plants, especially in Pittsburgh and the Atlantic Coast districts, have had so many demands for power to take care of war needs that they have found it necessary to ask the Priority Committee at Washington to designate which plants should be given preference. Some industries were given current for five days of the week instead of six, or for eighteen hours instead of twenty-four. As expenses, especially local, are costing the utilities more than in the past, it is apparent that if a number of the utilities are to remain solvent, rates must be raised by the Commission.

Considerable discussion followed, led by H. O. Garmon, Chief Engineer of the Indiana Public Service Commission, and George Hubley, Manager of the Merchants' Heat & Light Co. of Indianapolis.

An illustrated lecture on Concrete Ships and Barges was given by J. E. Freeman, of the Portland Cement Association, Chicago, Ill., pointing out the great possibilities of concrete, and of how stability is maintained in ships and barges.

A paper entitled Vocational and Industrial Education was given by A. S. Hurrell, Assistant Superintendent of Vocational and Industrial Education of the Indianapolis Public Schools.

At the evening session Mr. Will H. Hays, Chairman of the State Council of Defense of Indiana, delivered an address on the subject of The Engineer and the State Council of Defense, in which he brought out that every citizen has a patriotic duty to perform, but upon the engineer particularly the burden rests. The Indianapolis Engineers' Club was praised most warmly for the active influence and help extended to the state in the organization of the Battalion of Engineers of Indiana.

The concluding number on the program was an illustrated lecture by W. S. Culver, District Engineer of the General Electric Company, Cincinnati, Ohio, on The King of the Rail.

W. A. HANLEY,
Section Secretary.

NEW ORLEANS

March 11. At a meeting of the Louisiana Engineering Society, to which the members of the A.S.M.E. Section were invited, A. M. Lockett, Mem.Am.Soc.M.E., delivered a lecture on The New Orleans Industrial Canal. Further details regarding the meeting will be published in a later issue of THE JOURNAL.

H. L. HUTSON,
Section Secretary.

NEW YORK

February 21. How non-essential work might be turned into aid toward winning the war, was a subject which brought forth much discussion at the meeting. Ten or twelve speakers representing as many industries discused the subject, each setting forth his reason for considering the industry he represented, an essential one. Among the speakers were the following: Calvin W. Rice, Secretary, A.S.M.E.; Frederick W. Keough, Editor of *American Industries*, published by the National Association of Manufacturers: William Hamlin Childs, President of the Barrett Company; Sterling H. Bunnell, of R. Martens & Company; Horace B. Cheney, Jr., Vice-President of Cheney Brothers; Charles T. Main, President, A.S.M.E.; J. H. Haas, of the Loft Candy Company; Erik Oberg, Editor of *Machinery;* C. R. McMillen, of the Union Paper Bag Corp.; Frank Mossberg, of Attleboro, Mass.; P. W. Henry, of the American International Corporation, and Prof. D. D. Jackson, of Columbia University.

A detailed report of the meeting will be found in the Technical Section of this issue.

March 19. Terminal Facilities of New York was the subject of the meeting and was discussed by the following speakers, each covering a special phase of the subject: A. B. Pough presented the first topic, on Demands, including Pre-War, War, After-War and Future Demands. B. F. Cresson, Jr., discussed Land Facilities to meet the demands, such as railroads, marginal railroads, trucking and warehouses. W. J. Barney spoke on the Water Facilities to meet the demands, such as harbor, rivers, canals, docks, lighterage and mechanical. Deficiencies and Their Correction were discussed by George H. Pride. Agencies in Development, such as private capital, city, state, and national Government, were covered by Ira Place, and Charles Whiting Baker gave a résumé of the entire subject, offering a great many practical suggestions.

W. HERMAN GREUL,
Section Secretary.

PHILADELPHIA

March 26. Dr. S. W. Stratton of the United States Bureau of Standards delivered a talk on Recent Developments in Methods of Measurement. Further details will be published in a later JOURNAL.

JOHN P. MUDD,
Section Secretary.

PROVIDENCE

March 4. At the first Annual Smoker and General Meeting of the Providence Engineering Society, Gov. R. Livingston Beekman gave an interesting acount of his experiences at the battlefront.

March 12. Under the auspices of the Machine-Shop Section, Henry K. Spencer, of the Blanchard Machine Company, read a paper on The Production of Flat Surfaces by Modern Surface Grinding Machines.

March 13. At the Power-Section Meeting Mr. Warren F. Hodges presented a paper on Motor Troubles, and a second paper on the subject of Automobile Starters was given by Alfred Maille.

March 22. Mr. G. Douglas Wardrop, Editor of the *Aerial Age*, gave an interesting lecture on War in the Air. Mr. Calvin W. Rice, Secretary of the A.S.M.E., delivered a short address on Methods of Coöperation in Meeting Present Emergencies.

JAMES A. HALL,
Correspondent.

Student Branch Meetings

THE Metropolitan Student Branches of the Society located at Columbia University, New York University, Polytechnic Institute of Brooklyn and Stevens Institute of Technology, will hold the usual spring meeting at the Engineering Societies Building on Tuesday, April 9. There will be an afternoon and an evening session, with a buffet supper between the sessions.

The committee in charge of the arrangements is composed of two representatives of each of the Student Branches, with Herbert Lowenstein as chairman and Lincoln V. Aquadro as secretary. The committee has been exceedingly fortunate in getting the acceptances of the following speakers: F. R. Hutton, Richard B. Sheridan, Ira N. Hollis, G. D. Wardrop, M. H. Avram and Jack Armour. Other prominent engineers have been invited with a view to having a number of short interesting talks in preference to a few lengthy ones. The subjects to be touched upon include aviation, marine engineering, the need for technical training, especially in war times, the engineering requirements of our allies, the railroad engineer, and the young engineer in the army and navy.

The New York Section of the Society has decided to coöperate with the students by joining with them in this meeting and making it the April meeting of the Section.

The lecture by Mr. Wardrop on War in the Clouds is illustrated by motion pictures and lantern slides, and brings this phase of the situation up to the minute.

Members of the Society are especially urged to attend this meeting, not only to give these embryo engineers an opportunity to meet some of those established in the profession, but also because of the opportunity afforded for meeting prospective assistants to take positions upon graduation or temporarily during the vacation period. It is hoped that a number of members will make a point of being present to give encouragement to these young engineers in making a success of the meeting. All technical students, whether student members or not, are likewise urged to attend. Those desiring to participate in the supper should notify the secretary's office not later than noon, April 9.

UNIVERSITY OF CINCINNATI

February 21. A paper on the Construction of Concrete Ships and Barges was presented by J. E. Freeman.

March 21. A paper on Shop Kinks was presented by Henry Ritter, Mem.Am.Soc.M.E.

Professor John T. Faig, Mem.Am.Soc.M.E., delivered a paper on The Economic Use of Coal by Communities. In view of the increasing need of conservation at this time, a method of using coal by which all of the by-products are saved was fully discussed.

Mr. C. W. Carpenter, Mem.Am.Soc.M.E., who has had considerable experience in training thousands of women for war industry, delivered an interesting lecture on The Training of Women for Industry.

J. T. FAIG,
Section Secretary.

CARNEGIE INSTITUTE OF TECHNOLOGY

February 13. An illustrated talk was given by W. C. Wright on Modern Foundry Methods and Equipment, which showed present foundry practice and the various devices for increasing the output and decreasing the number of skilled molders necessary. The subject of the woman worker was presented, and the matter of making her surroundings more pleasant and sanitary and the need for safety devices in the line of work in which she is employed were discussed.

H. D. KRUMMEL,
Branch Secretary.

UNIVERSITY OF COLORADO

March 7. Professor Black delivered an illustrated lecture on Properties of Commercial Steam Pipe Coverings. The lecture covered experiments performed at the University of Wisconsin. The different methods of measuring heat dissipation through pipe coverings, and the means of measuring temperatures, giving preference to the copper-constantan thermocouple, were discussed. Various curves were shown indicating the comparative insulating properties of different coverings and also the saving possible through efficient covering.

H. O. CROFT,
Branch Secretary.

POLYTECHNIC INSTITUTE OF BROOKLYN

March 8. Benjamin Offen was elected treasurer, to succeed Joseph L. Kopf.

Mr. Arthur Seubert, in his talk on Engineering Education, pointed out that by affiliating with engineering or college societies the student's powers of leadership, tact and resourcefulness are developed.

A special war-time course in radio engineering, covering theory, code and laboratory work, is being given at the Institute and is open to seniors in mechanical engineering.

NATHAN N. WOLPERT,
Branch Secretary.

UNIVERSITY OF WASHINGTON

An inspection trip was made to the Ford assembling station and to the sub-stations of the Seattle Light & Power Company. Forty members and guests of the university participated.

The university is coöperating with the Government by having a Reserve Officers Training Corps in which underclassmen receive eight hours of training a week with upperclassmen as officers and members of the faculty as instructors, the latter being in the R.O.T.C. An A.U.S. Naval Training Station is located on the Campus with an enrollment of about a thousand and a course for marine operating engineers under the direction of the U. S. Shipping Board is given by the mechanical engineering faculty to men from all over the West and Southwest. Over a thousand men from the University of Washington are now in the service, and a good share from the engineering school are now in various branches of the Engineering Corps and other branches of service.

FAIRMAN B. LEE,
Branch Secretary.

TENTH ROLL OF HONOR

ONE HUNDRED AND SIXTY-EIGHT additional names of members of The American Society of Mechanical Engineers are added to our ever-lengthening Roll of Honor, and the stars on the service flag now number over 900.

ABERCROMBIE, JAMES H., Captain, British Army.
ABERNETHY, W. K., Aviation Corps, U. S. Army.
ALDEN, J. L., Second Lieutenant, Ordnance Department, N. A.
ALLEN, HENRY A., Colonel, Commanding 108th Engineers, 33rd Division, Camp Logan, Houston, Texas.
ANTONSANTI, LOUIS, 2nd Officers' Training Camp, San Juan, Porto Rico.
ARKELL, WILLIAM C., First Lieutenant, Ordnance Officers' Reserve Corps.
ASHLEY, EDWARD E., JR., First Lieutenant, Engineering Section, Signal Corps, U. S. Army.
BADOWSKI, ALFRED, Captain, Ordnance Department, U. S. Army.
BAIRD, JAMES T., JR., Captain, Ordnance Officers' Reserve Corps.
BAKER, PHILIP C., Lieutenant, 79th Aero Squad, American Expeditionary Forces, France.
BANQUET, CAMILLE, JR., Second Lieutenant, 1st Company, Coast Artillery Corps, Fort Mott, New Jersey.
BARRY, THOMAS J., Company A, 37th Engineers, Fort Meyer, Va.
BEARD, THEODORE H., Lieutenant, Sandy Hook Proving Ground, Fort Hancock, New Jersey.
BEHR, F. J., Major, Coast Artillery Corps, U. S. Army.
BENSEL, JOHN A., Major, Engineer Officers' Reserve Corps, U. S. Army.
BOLLES, FRANK G., Major, Ordnance Department, U. S. Army.
BOND, WILLIAM L., First Lieutenant, Ordnance Officers' Reserve Corps, Frankford Arsenal, Pa.
BOWLES, HARDY, Captain, 23rd Engineers, American Expeditionary Forces, France.
BRES, EDWARD W., Lieutenant, 312th Engineers, Camp Pike, Arkansas.
BROOKS, J. ANSEL, Captain, Aviation Section, Signal Reserve Corps.
BROWN, CLINTON, First Lieutenant, Carriage Section, Production Division, Ordnance Officers' Reserve Corps.
BROWN, EUGENE L., JR., First Lieutenant, Engineer Officers' Reserve Corps.
BUCKLEY, Captain, Ordnance Officers' Reserve Corps, Frankford Arsenal, Philadelphia.
BUYERS, A. S., Captain, Coast Artillery Corps, U. S. Army.
CAMPBELL, JEREMIAH, Major, Engineer Officers' Reserve Corps, American Expeditionary Forces, France.
CAROTHERS, CHARLES G., Captain, Company I, Engineer Officers' Reserve Corps.
CARTER, WILLIAM D., Captain, Ordnance Officers' Reserve Corps.
CASE, MILO M., Major, Inspection Department, Ordnance Officers' Reserve Corps.
CHAPMAN, EDMUND E., Captain, Ordnance Officers' Reserve Corps.
CLARKSON, ROBERT C., JR., Mechanical Engineer, Signal Corps, U. S. Army.
COBURN, FREDERIC G., Naval Constructor, U. S. Navy.
COLE, C. L., Captain, Ordnance Officers' Reserve Corps.
CONANT, WILLIAM S., Major, Ordnance Officers' Reserve Corps.
CONE, HUTCHINSON J., Commander, U. S. Navy, Navy Department, Washington, D. C.
CONVERSE, BERNARD T., Major, Ordnance Officers' Reserve Corps, Watervliet Arsenal, Watervliet, New York.
CORDES, PAUL H., First Lieutenant, Company C, 30th Engineers, Gas and Flame Regiment, Fort Myers, Va.
CUTLER, JAMES B., Lieutenant, U. S. Reserve, Battery E, 319th Field Artillery, Camp Gordon, Georgia.
DAVIES, CLARENCE E., First Lieutenant, Ordnance Officers' Reserve Corps, Frankford Arsenal, Pa.
DAVIES, T. R., First Lieutenant, Ordnance Officers' Reserve Corps.
DEXTER, HARRIS E., Lieutenant, 30th Engineers, American Expeditionary Forces.
DOLL, WILLIAM E., Lieutenant, 35th Engineers, U. S. R., Camp Grant, Rockford, Ill.
EDDISON, BARTON, Lieutenant, Junior Grade, U. S. Naval Reserve Force.
EDDY, BENJAMIN S., First Lieutenant, Engineer Officers' Reserve Corps.
EISENHART, H. W., Captain, Production Division, Carriage Section, Ordnance Officers' Reserve Corps, U. S. A.
ENGESSER, B. M., Aviation Section, Signal Corps, Army School of Military Aeronautics, M. I. T.
EVANS, B. R., Machinist's Mate, 2nd Class, United States Navy, U. S. S. B-1 Submarine.
FARRINTON, THOMAS H., Captain, Engineer Officers' Reserve Corps, Fort Leavenworth, Kansas.
FERGUSON, W. CRAIG, First Lieutenant, Ordnance Officers' Reserve Corps.
FLAGG, PAUL M., Private, Company F, 304th Engineers, National Army, Camp Meade, Maryland.
FOORD, JAMES L., Lieutenant-Commander, N. N. V., U. S. Navy, U. S. Training Station, Great Lakes, Ill.
FORD, JOHN D., Rear Admiral, U. S. Navy.
FORSYTH, JAMES M., Candidate Second Officers' Training Camp, Fort Sheridan, Ill.
FRASER, D. ROSS, First Lieutenant, Engineer Officers' Reserve Corps.
FRAUENS, FRANK H., Company A, 42nd Engineers, Camp American University, Washington, D. C.
FULWEILER, JOHN E., Ensign, U. S. Naval Reserve Corps, U. S. S. *James*.
GALLAHER, CHARLES W., First Lieutenant, Iowa Engineers, Brownsville, Texas.
GIBBS, CHARLES W., Machinist's Mate, Second Class, U. S. Naval Reserve Force.
GIBSON, JULIAN B., Second Lieutenant, Quartermaster's Corps, National Army, Camp Meade, Maryland.
GILBERT, HUNTLEY H., Captain, Ordnance Officers' Reserve Corps, Rock Island Arsenal, Ill.
GOODIER, HOMER W., First Class Private, Aviation Section, Signal Enlisted Reserve Corps.
HAASIS, P. W., Aviation Section, Signal Officers' Reserve Corps.
HAWES, ALEX. G., Captain, Ordnance Officers' Reserve Corps.
HAYES, WILLIAM PARSONS, Lieutenant, Fleet Naval Reserve, U. S. S. *Niagara*.
HEIDELBURG, FRED M., First Lieutenant, Inspection Division, Ordnance Department, U. S. A.
HENRY, ALEXANDER S., JR., Aviation Corps, No. 104th Aero Squadron, U. S. Army.
HICKS, RUFUS W., JR., First Lieutenant, Ordnance Officers' Reserve Corps.
HORNER, BENJAMIN B., Second Lieutenant, Engineer Officers' Reserve Corps, 311th Engineers, Camp Grant, Ill.
HULBURT, WYNNE D., Second Lieutenant, 71st Regiment Engineers (Railway), American Expeditionary Forces, France.
HUSTED, CLIFFORD M., Captain, Engineers, U. S. Army.
HUTCHINSON, H. H., Captain, Ordnance Officers' Reserve Corps.
IDDLES, ALFRED, First Lieutenant, Engineering Bureau, Ordnance Officers' Reserve Corps.
IRELAND, MARK L., Major, Quartermasters' Corps, Fort Sam Houston, Texas.
JAMES, RICHARD M., Private, Ordnance Training School, Pittsburgh, Pa.
JAMIESON, CHARLES C., Colonel, Ordnance Department, N. A.
JENKS, GLEN F., Lieutenant-Colonel Ordnance Department, American Expeditionary Forces, France.
JUNKERSFELD, PETER, Lieutenant-Colonel, Quartermaster Corps, N. A.
KEENAN, WALTER M., First Lieutenant, Aviation Section, Signal Officers' Reserve Corps.
KEET, CLARENCE T., Company A, 304th Engineers, Camp Meade, Maryland.
KENNEDY, GRAFTON S., Lieutenant, Coast Artillery Corps, U. S. Army, Fort Morgan, Ala.
KENT, ROBERT W., First Lieutenant, Ordnance Officers' Reserve Corps.
KESSLER, HERBERT, First Lieutenant, Ordnance Officers' Reserve Corps.
KING, WILLIAM R., Major, Ordnance Officers' Reserve Corps.
KINGSBURY, CHESTER L., Lieutenant, Ordnance Officers' Reserve Corps.
KNIGHT, WILLIAM, First Lieutenant, Aviation Section, Signal Officers' Reserve Corps.
KOCH, CHARLES, Ordnance Draftsman, Philadelphia Navy Yard.
LANE, ABBOT A., First Lieutenant, Signal Officers' Reserve Corps.
LEWIS, J. CLIFFORD, Construction Department, Signal Corps, U. S. Army.
LIPSNER, BENJAMIN B., Captain, Signal Corps, U. S. Army.
LOGAN, ORWELL, National Army, Camp Upton, Yaphank, Long Island.
LONN, JULIUS M., First Lieutenant, Ordnance Department, Frankford Arsenal, Philadelphia, Pennsylvania.
LOWMAN, ROY L., Lieutenant, United States Naval Reserve Force.
MACDONALD, HOWARD D., First Lieutenant, 131st U. S. Infantry, Camp Logan, Texas.
MCCUNE, JOSEPH C., First Lieutenant, Engineer Officers' Reserve Corps.
MCKINNEY, WILLIAM P., U. S. Navy, Naval Aviation Corps.
MCMURRAY, J. H., Captain, Ordnance Department, N. A.
MAGEE, CHRISTOPHER, Company M, 332d Infantry, Camp Sherman, Ohio.
MARTIN, EDWARD, U. S. Navy, Naval Aviation Corps.
MASSEY, GEORGE B., Lieutenant, Junior Grade, Fleet Reserve.
MAXFIELD, HOWARD H., Colonel, 19th Regiment Engineers (Railway), American Expeditionary Forces, France.

MAXWELL, GEORGE L., Company A, 29th Engineers, American Expeditionary Forces.
MEIGS, ROBERT R., First Lieutenant, 19th Regular, Engineers (Railway), American Expeditionary Forces, France.
MERRILL, ALBERT S., First Lieutenant, Inspection Division, Ordnance Officers' Reserve Corps.
MESSNER, MANFRED, Private, Company K, 312th Infantry, Camp Dix, N. J.
MEYLER, ROBERT G., First Lieutenant, Ordnance Officers' Reserve Corps, Rock Island Arsenal, Rock Island, Ill.
MILLER, CLARENCE A., National Army.
MOODY, FREDERICK H., Major, 116th Battalion, Canadian Infantry, France.
MOYER, WILL D., Captain, Coast Artillery, Officers' Reserve Corps, Fort McKinley, Portland, Maine.
NESBIT, JOSEPH, N. G., Ordnance Division, Sandy Hook Proving Ground, Fort Hancock, New Jersey.
NORRIS, JOHN B., JR., First Lieutenant, Engineer Officers' Reserve Corps.
OSGOOD, W. H., Lieutenant, United States Navy.
OVERMIRE, WILFRED J., Private, Company C, 334th Infantry, Camp Zachary Taylor, Kentucky.
PACKARD, H. N., Lieutenant, Junior Grade, Naval Reserve Force.
PALMER, BRIAN C., Science and Research Division, Signal Corps, U. S. Army.
PARKHURST, HARLEIGH, Major, Field Artillery, U. S. Reserve, 14th Field Artillery, Fort Sill, Oklahoma.
PEMBERTON, C., Lieutenant, Ordnance Department, Camp Jackson, South Carolina.
POHLE, RICHARD F., First Lieutenant, Inspection Department, Ordnance Officers' Reserve Corps.
POWELL, PAUL R., First Lieutenant, Engineer Officers' Reserve Corps, U. S. Army.
RAY, MARTIN H., Captain, Aviation Section, Signal Corps, U. S. A.
REILLY, CHARLES J., Company C, 21st Engineers, Camp Grant, Rockford, Ill.
RIDER, DAVID S., Private, Company E., Private, 10th Engineers (Forestry), American Expeditionary Force, France.
RILEY, JOSEPH C., Major, Air Service, Signal Corps, American Expeditionary Forces, France.
ROBERTS, RICHARD F., Equipment Division, Signal Corps, U. S. A.
ROSENFIELD, HAROLD, Aviation Section, Signal Officers' Reserve Corps.
ROSS, SIR CHARLES H. A. F. L., Lieutenant, Ordnance Officers' Reserve Corps, Fort Hancock, Sandy Hook, New Jersey.
RUSS, JOHN B., First Lieutenant, Engineer Officers' Reserve Corps.
RYDER, FREDERICK W., 1st Battery, Reserve Officers' Training Camp, Fort Niagara, New York.
SAUERS, JOHN A., First Lieutenant, Ordnance Officers' Reserve Corps, Frankford Arsenal, Bridesburg, Pennsylvania.
SCHAUM, OTTO W., Aeronautical Mechanical Engineer, Signal Corps, U. S. Army.
SCHMIDT, JOHN D., Ensign, U. S. Naval Reserve Force.
SCHUPP, ARTHUR A., Second Lieutenant, Signal Corps, U. S. Army.
SCOTT, ROSSITER S., Captain, Engineers, U. S. Reserve, 8th Company, Camp Lee, Va.
SHARKEY, W. E., Lieutenant, Ordnance Officers' Reserve Corps.
SHARP, RALPH E., Camp Meade, Maryland.
SLADE, HENRY L., JR., First Lieutenant, Ordnance Officers' Reserve Corps.
SPAULDING, HOLLON C., Captain, Quartermaster Reserve Corps, Army Transport Service.
STREETER, ROBERT L., Major, Ordnance Department, National Army.
STULTS, WILLIAM R., Private, National Army, 18th Company, 5th Training Brigade, Depot Brigade, Camp Devens, Ayer, Mass.
STUREMAN, ROBERT V., Quartermaster Corps, Camp Logan, Houston, Texas.
SWIFT, HARLEY L., First Lieutenant, 16th Regiment Engineers (Railway), American Expeditionary Forces, France.
SWINTON, DAVID R., First Lieutenant, National Army.
THOMPSON, JOHN T., Colonel, United States Army.
TOWER, GLENN L., Lieutenant, Ordnance Department, National Army.
TROWBRIDGE, AMASA, Major, Ordnance Officers' Reserve Corps, Watervliet Arsenal, Watervliet, New York.
TUTTLE, GEORGE W., Aviation Section, Signal Reserve Corps.
VAN KEUREN, E. B., Captain, Ordnance Officers' Reserve Corps.
VAUCLAIN, A. C., Major, Ordnance Officers' Reserve Corps.
VEHSLAGE, H. E., First Lieutenant, Purchase Section, Gun Division, Ordnance Officers' Reserve Corps.
VOGT, CLARENCE W., Captain, Ordnance Department, N. A.
VOORHEES, JOHN R., Lieutenant, Ordnance Department, U. S. Army, Sandy Hook Proving Ground, Fort Hancock, N. J.
WADDELL, ROBERT, Lieutenant, Royal Flying Corps, British Army.
WARREN, WILLIAM H., Corporal, Headquarters Company, 340th Field Artillery, National Army, Camp Funston, Kansas.
WEBSTER, LAWRENCE B., Captain, Ordnance Officers' Reserve Corps.
WEEKS, PAUL, Captain, Motor Equipment Section, Ordnance Officers' Reserve Corps.
WEGNERER, FRANCIS A., Naval Reserve Flying Corps.
WEINBERG, GEORGE S., Major, 30th Engineers, American Expeditionary Forces, France.
WELFORD, P. G., Gunner, Canadian Field Artillery.
WELLS, G. A., Captain, Carriage Division, Motor Equipment Section, Ordnance Officers' Reserve Corps.
WESTERVELT, W. I., Colonel, Field Artillery, N. A., American Expeditionary Forces, France.
WHEELER, F. B., Gas Defense Service, American Expeditionary Forces, France.
WHITLOCK, ELLIOTT H., Lieutenant-Colonel, 24th Engineers, N. A., American Expeditionary Forces, France.
WIELAND, C. F., Captain, Ordnance Officers' Reserve Corps, Manila Ordnance Depot, Manila, P. I.
WIGHTMAN, GEORGE A., Sergeant, Ambulance Company, Training Camp Zachary Taylor, Louisville, Kentucky.
WILBUR, R. L., First Lieutenant, Ordnance Officers' Reserve Corps, U. S. Army.
WILLIAMS, HAROLD E., Captain, Field Artillery, Officers' Reserve Corps.
WILLIAMS, R. G., Captain, Ordnance Officers' Reserve Corps.
WOODCOCK, WILLIAM E., Second Lieutenant, Engineer Officers' Reserve Corps.
YCASIANO, F. R., Captain, Radio Company, Field Battalion, Signal Corps, National Guard, Philippine Islands.
ZEIGER, KENNETH G., Student Officers' Training Camp, 2nd Coast Artillery Corps, Fort Winfield Scott, California.
ZINK, ROBERT E., Captain, Ordnance Officers' Reserve Corps.

PERSONALS

IN these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by April 16 in order to appear in the May issue.

CHANGES OF POSITION

HENRY A. STRINGFELLOW has left the employ of the Epping-Carpenter Pump Company, Pittsburgh, Pa., to assume the position of first assistant engineer with R. Winthrop Pratt, consulting engineer, on the design of the new filtration plant for the City of Detroit, Mich.

JOHN H. WILHELM, formerly superintendent of the Gage Department of Frankford Arsenal, Frankford, Pa., has become affiliated with the Blair Tool and Machine Works, Inc., New York, in the capacity of chief engineer.

B. F. SAFBERG has left the employ of the Babcock and Wilcox Company and has become identified with the production department of the Emergency Fleet Corporation, Washington, D. C., in charge of boiler production.

JOHN W. MERSHON has resigned his position as mechanical engineer of Remington Arms, Bridgeport, Conn., to take a position as plant engineer at Bayles Shipyard, Port Jefferson, N. Y.

GEORGE M. KEENAN, test engineer of the Union Electric Company, St. Louis, Mo., has assumed the duties of chief engineer of the Little Rock Railway and Electric Company, Little Rock, Ark.

LEO LOEB has severed his connection with the Coal Companies with which he has been associated within the past four years, and has joined the organization of Day and Zimmermann, Inc., of Philadelphia, Pa.

E. H. NELSON has resigned as chief engineer of the Blake-Knowles Plant of the Worthington Pump and Machine Corporation, and has accepted the position of general works manager with the Griscom-Russell Company, of New York, with headquarters at Massillon, Ohio.

ROBERT H. SCHAFER has resigned as mechanical superintendent of the Bridgeport Brass Company, to accept a position as mechanical engineer of design and equipment of the Brown's Copper and Brass Rolling Mills Company, Ltd., Toronto, Ont., Canada.

DANIEL M. SACHS, until recently vice-president and general manager of the Northern Pipe Line Company, Oil City, Pa., has accepted the position of general manager of the New York Transit Company, Binghamton, N. Y.

A. H. LANE has severed his connection with the Eastern Machinery Company, New Haven, Conn., with which firm he held the position of engineer for the past three years, and has taken a position with the Grant Hammond Manufacturing Corporation, of New York, as special machine designer.

Z. E. SARGISSON has resigned his position as chief designing engineer of the Illinois Traction System, Peoria, Ill., to accept the position of assistant works engineer of the Pan Motor Company, of St. Cloud, Minn.

O. D. A. PEASE, formerly assistant foreman of the test department of the Pennsylvania Railroad at Altoona, Pa., has accepted an appointment with the Bureau of Explosives, as inspector, with headquarters in New York.

EARL E. ADAMS, lately sales manager of the powdered coal department of the Bonnot Company, Canton, Ohio, and for some years in charge of gas producer work for the Power and Mining Machinery Company, has accepted a position as sales engineer for the Smith Gas Engineering Company, and will shortly be located at Dayton, Ohio, where the new plant of the Smith Gas Engineering Company is nearing completion.

WILLIAM T. PRICE has recently resigned as manager and chief engineer of the De La Vergne Machine Company, oil engine department, to become president of the P-R Engine Company of New York, and second vice-president of The Rathbun-Jones Engineering Company of Toledo, Ohio, which will undertake the sale and manufacture respectively of Price-Rathbun stationary and marine oil engines built in accordance with a new principle of fuel injection developed by Mr. Price during the past several years.

ANNOUNCEMENTS

The following appointments have been announced by the Worthington Pump and Machinery Corporation: JAMES E. SAGUE, consulting engineer, has been appointed vice-president in charge of engineering and manufacture; WILLIAM GOODMAN, manager of the Laidlaw Plant, appointed assistant to vice-president; WILLIAM SCHWANHAUSSER has been reappointed chief engineer; CHARLES E. WILSON, appointed assistant general sales manager.

ULDRIC THOMPSON, JR., formerly chief engineer of the International Steel and Ordnance Corporation, and who has until recently been serving in an advisory capacity in equipping the new artillery ammunition plant at Rock Island Arsenal, has opened an office at 120 Broadway, New York, under the firm name of Uldric Thompson, Inc., consulting and industrial engineers.

J. C. BERTSCH has resigned his position as refrigerating engineer with The Westinghouse Electric and Manufacturing Company machine works, to engage as consulting engineer in the design of thermo-compressors for air, steam and ammonia, and apparatus for rubber mill, gasoline extraction and marine refrigeration, with office in Pittsburgh, Pa.

RICHARD F. ROBERTS has been given an indefinite leave of absence from the Chile Exploration Company, to enter the equipment division of the U. S. A. Signal Corps, Washington, D. C.

CHARLES W. GIBBS has been enrolled in the U. S. Naval Reserve Forces as Machinist's Mate, 2nd Class, and will be detailed for duty at the Fuel Oil Testing Plant, Philadelphia Navy Yard.

HENRY E. LONGWELL announces his resignation as vice-president and general manager of The Westinghouse Air Spring Company, New Haven, Conn.

JAMES A. SHEPARD, vice-president and chief engineer of the Shepard Electric Crane and Hoist Company, Montour Falls, N. Y., gave an interesting talk on Designing at the February 22d meeting of the Shepard Progress Club.

HAROLD I. MARKEY has left the engineering department of the Firestone Tire and Rubber Company, Akron, Ohio, to take the position of assistant chief engineer of the Diamond Chain and Manufacturing Company, Indianapolis, Ind.

A. C. VOORHEES has resigned his position as chief submarine draftsman for the California Shipbuilding Company, to accept the position of assistant to the general superintendent with the Schaw-Batcher Company Pipe Works of San Francisco, which has contracts for 18 freighters for the Emergency Fleet Corporation.

FORREST H. BLANDING, formerly identified with the McEwen Manufacturing Company, Tulsa, Okla., as superintendent, has accepted a similar position with the ordnance works of the Otis Elevator Company, Chicago, Ill.

CHARLES A. MALONEY, efficiency engineer with the United Gas Improvement Company, Philadelphia, Pa., has become affiliated with the Merchant Shipbuilding Corporation, Bristol, Pa., in the capacity of mechanical engineer.

FRANCIS A. WEGENER is no longer connected with the Welsbach Company, Gloucester, N. J., having enlisted in the U. S. Naval Reserve Flying Corps. He is at present under instruction at Columbia University, New York.

FRANK O. WELLS, president of the Greenfield Tap and Die Corporation, is one of the directors of the Lincoln Twist Drill Company, of Taunton, Mass.

ROBERT P. LAY, assistant engineer of the experimental motor division of the Curtiss Aeroplane and Motor Corporation, Buffalo, N. Y., has been transferred to the Garden City, L. I., N. Y., plant of The Curtiss Engineering Corporation.

JOHN YOUNGER of the Pierce-Arrow Motor Truck Company, Buffalo, N. Y., is serving in the engineering division of the motor transport section of the Quartermasters Corps.

ROBERT T. KENT has become associated with Meyer, Morrison and Company, consulting engineers, of New York.

NECROLOGY

JOHN PORTERFIELD SPARROW

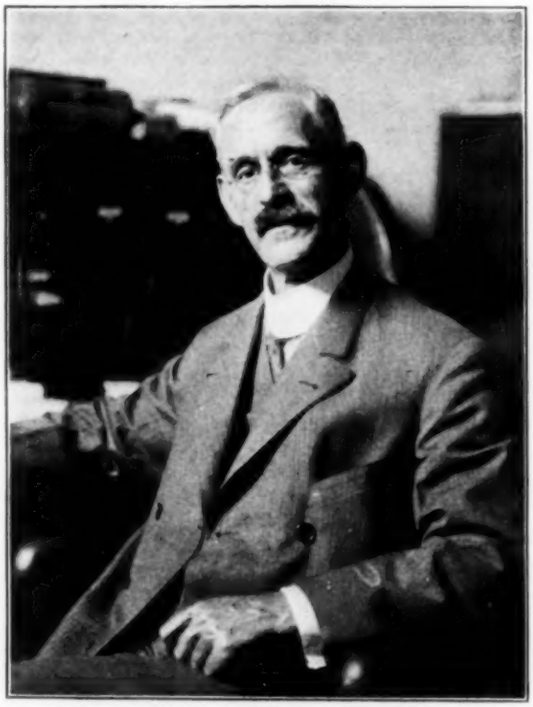
John Porterfield Sparrow, for many years a member of the Society, died at his home in Flatbush, Brooklyn, on March 18, 1918. He was born in Portland, Maine, on March 17, 1860.

Mr. Sparrow was an engineer by inheritance and education, his father, John Sparrow, being well known in the engineering field. His early education was obtained in the public schools of Portland, but this was largely supplemented by his father's teachings in physics, chemistry and engineering.

In 1879, being interested in sugar manufacture, Mr. Sparrow was taken to Europe by his father to study the industry, and while there visited all of the larger engineering works. In 1880 he entered the Portland Company's locomotive and marine-engine works as an apprentice. He served his apprenticeship and became a toolmaker and erector for that company, leaving them in 1888 to work for the Sprague Electric Company. During the next two years he acted as superintendent for the Sprague Electric Company, in charge of construction of electric railways in the various parts of the country. In 1890 he went to New Orleans for the New Orleans Electric Company on construction work. In 1892 he joined the construction staff of the Edison General Electric Company and was

employed in building lighting and power plants for them and the Canadian General Electric Company until 1895. In 1895 he joined the staff of the construction department of the Edison Electric Illuminating Company of New York, and in 1898 became superintendent of construction, having charge of all of the construction, which included the new Waterside Station, at that time the largest and most important construction of its kind which had been attempted. In 1906 he became chief engineer of The New York Edison Company in charge of construction and operation, the position he held at the time of his death.

Mr. Sparrow became a member of the Society in 1898 and was an active member, serving on various committees. At the time of his death he was Chairman of the Committee on Standardization of Flanges and Pipe Fittings, and had just finished the completed report on that subject. On February 1, 1918, he was appointed Chairman of the Advisory Board of the Power Test Committee. His work along these lines has been particularly valuable, as his long experience, trained judgment and personal influence insured the reconcilation of conflicting interests.



JOHN PORTERFIELD SPARROW

In the Association of Edison Illuminating Companies he was a member of the Committee on Steam Plants from 1906 up to the present time, and was chairman in 1910, 1912 and 1913. In this work his most valuable contributions were those in connection with coal testing and burning. Before the Edison Association he presented a number of papers on boiler-plant problems.

In the National Electric Light Association he was a member of the Committee on Prime Movers for a number of years, and was a frequent contributor to the Question Box.

Shortly after the United States entered the war he made a number of tests for the Naval Consulting Board in connection with smoke abatement on ships as a protection against submarines.

Mr. Sparrow's hobbies were largely of an engineering character. In photography his work as an amateur rivaled many professionals, and he was one of the first to take up color photography. Microscopy, as a result of his early training, was always one of his chief aids and his work on the photomicrography of lamp filaments is well known. In later years he turned to metallography in connection with the ever-present subject of the corrosion of condenser tubes, and assisted in the settling of important questions of heat treatment in the manufacture of this material. His knowledge of physical science was fundamental and he was an adept in the mechanical handling and manipulation which is a necessity in research work of this kind.

Mr. Sparrow had a charming personality and his optimistic temperament, uniform courtesy and entire absence of contentiousness endeared him to a host of friends. He was held in affectionate regard by the officials of The New York Edison Company, to whom his passing away comes as a personal loss.

FRANCIS E. GALLOUPE

Francis E. Galloupe was born in Lynn, Mass., on October 3, 1855. He attended the high school in Lynn and later the Massachusetts Institute of Technology at Boston, where he took the course in mechanical engineering and received his degree in 1876.

Upon graduation he was connected with the Rhode Island Locomotive Works for about two years and spent approximately the same time with the Baldwin Locomotive Works and with the Brooks Locomotive Works. The next two or three years he devoted to the design of rolling stock for the proposed Meigs Railroad. Following this period, he was engaged in the real-estate business. He was interested in developing and redeveloping properties and handled some very important transactions along this line. He possessed an unusually complete system of recording engineering information.

Mr. Galloupe was a charter member of the Society. He died in Boston, January 5, 1918.

JOSEPH FREDERIC KLEIN

Joseph Frederic Klein was born in Paris, France, on October 10, 1849. His parents were Huguenots and came to America when he was two and a half years old. They first settled in Bridgeport, Conn., where he attended the public schools, and moved to New Haven in 1858, where he attended the Eaton Grammar School. After finishing his common-school education he was employed as a machinist in the New Haven shops. Later, in 1866, he attended the famous military school of Gen. William H. Russell, which was also a college preparatory school. He was employed by Sargent & Co. and the W. & E. T. Fitch Co. as salesman and shipping clerk, always studying during his spare moments, as he was determined to get a college education.

His studious disposition won him many friends, among whom was the distinguished Prof. Willard J. Gibbs, of Yale University, who took a personal interest in him and through whose influence he decided to enter Sheffield Scientific School of Yale University. This he did in 1868, taking the course in mechanical engineering, then called dynamic engineering, and being graduated with the degree of Ph.B. in 1871. One of his classmates was Mansfield Merriman, afterward his associate at Lehigh University as professor of civil engineering. He was appointed the first instructor of the first evening school started in New Haven in 1868.

From 1871 to 1873 he did experimental work for Prof. W. P. Trowbridge of Yale and others. He also took a graduate course in mechanical engineering, receiving the degree of D. E. (Dynamic Engineer) at Sheffield in 1873. He entered the employ of Colt's Armory, Hartford, Conn., in 1873, first as draftsman and finally as assistant to the chief engineer, Mr. Charles B. Richards, that company being engaged at the time on the work connected with the heating and ventilating system of the (then) new State Capitol at Hartford. Mr. Richards, the inventor of the Richards steam-engine indicator, later became chief engineer of the Southwark Foundry and Machine Co., of Philadelphia, and subsequently professor of mechanical engineering at Yale University. Professor Klein was in the employ of Colt's from 1873 to 1877.

In 1877 Professor Klein returned to Sheffield Scientific School as instructor in mechanical engineering, being the assistant in this department of the late Prof. A. Jay DuBois. In the fall of 1881 he was called to Lehigh University to establish and develop a course in mechanical engineering, and was connected with that institution up to the time of his death. In 1887 to 1888 he was secretary of the faculty. In addition to his duties as head of the mechanical-engineering department he was appointed dean of the faculty in 1907, which additional work he has performed with distinction. From February to April, 1910, he was acting president of the University.

Professor Klein's published books are: Mechanical Technology of Machine Construction, 1884; Elements of Machine Design, 1889; Table of Coördinates for Laying Out Accurate Profiles of Gear Teeth, 1889; The Design of a High-Speed Steam Engine, 1892; and The Physical Significance of Entropy or of the Second Law, 1910. Also the following translations from the German:

Weisbach-Hertmann's Mechanics of Machinery of Transmission, 1883; Zeuner's Treatise on Valve Gears, 1884; and Zeuner's Technical Thermodynamics, 1907. He spent a number of years in researches on Dynamics of the Shaft Governor, intending to issue a work on Flywheels and Governors; this was never completed, although a part of the results of his investigations are in use in the mechanical-engineering course in Lehigh. He also made extensive researches in Kinematics of Machinery. His magazine articles are: Absolute Zero of Temperature, *Van Nostrand's Engineering Magazine*, April, 1880, Vol. xxxii; Concerning $(T_1—T_0)/T_1$ or the Limit of Efficiency of Heat Engines, *Journal of The Franklin*

JOSEPH FREDERIC KLEIN

Institute, March-April, 1879; Table and Diagram for Determining the Diameter of Speed Cones when Connected by an Open Belt of Constant Length, *Journal of The Franklin Institute*, May, 1880; Cone Pulley Diameters, No. 2, *American Machinist*, October 22, 1881; The Law of Proportional Resistance, *Journal of Engineering Society of Lehigh University*, November, 1889; and New Construction of the Force of Inertia of Connecting Rods and Couplers, and Construction of the Pressures on Their Pins, *Journal of The Franklin Institute*, September-October, 1891.

With Mr. L. P. Breckenridge, then his assistant at Lehigh University, now professor of mechanical engineering at Sheffield Scientific School of Yale University, he conducted a series of tests for the Lehigh Valley Road during the summer of (probably) 1888. Among other purposes, the tests were to determine the relative performance value of three different types of locomotive valves, the plain slide valve, the Allen-Richardson balance valve and the piston valve. Incidentally measurements were made of the exact length of the road, and they showed the official record to be a half mile in error.

Professor Klein was elected to membership in the Society in 1881, one year after its organization, and in 1907, on the occasion of the celebration of his twenty-fifth anniversary at Lehigh, he was presented by the alumni of his department of the University with a life membership in the Society. He was an honorary member of Tau Beta Pi. He died on February 11, 1918.

WILLIAM BURNHAM

William Burnham was born in Philadelphia on March 20, 1846. He was educated in private schools in Philadelphia and Allentown, Pa., and at the Lawrence Scientific School, Cambridge, Mass. After spending some years in the employ of the Baldwin Locomotive Works, in 1871 he became assignee for William Butcher, who first manufactured steel locomotive tires in the United States. When this business was reorganized as the Standard Steel Works, he was made secretary and treasurer, subsequently becoming chairman of the board. He was also a director of the Baldwin Locomotive Works.

Mr. Burnham was a member of a number of clubs. He was president of the Pennsylvania Working Home for Blind Men. He became an associate of the Society in 1888. He died on February 25, 1918.

GEORGE SUNTER POWER

George S. Power was born on May 17, 1870, in Brantford, Ont. He was graduated from the high school in Gaylord, Mich., and later took a five years' course at Cooper Union, New York, three of which were devoted to science and two to architecture.

Upon the completion of his high-school course he acted as principal for three years of a school in Duncan City, Mich. His next position was with the First National Bank of Duluth, Minn., as bookkeeper. About 1893 he left for New York City, where he became superintendent of the J. & J. Morrison Co., plasterers. In 1896 he became connected with the Witherspoon Plaster Mill, where his work consisted in the designing and building of labor-saving devices. In the following years he was associated with the Jackson Architectural Iron Works in designing and drafting; the Manhattan Concrete Co. in figuring and estimating; V. Dorne Sons, New York, as superintendent and estimator, and with the Rock Plaster Co., New York and Hoboken, as superintendent. In 1903 he was employed by the Robins Conveyor Belt Co. to design conveyor machinery; he also supervised the erection of a new plant for the company at Passaic, N. J. In 1903 he became identified with the U. S. Gypsum Co., Chicago, Ill., where his work consisted of designing and building new and remodeling old

GEORGE SUNTER POWER

gypsum mills. From 1905 to 1916 Mr. Power was associated with the firm of Wickes Brothers, Saginaw, Mich., where he held successively the positions of draftsman, designer of new machines, superintendent, and general manager of the rock-drill department. For the past fourteen months, up to the time of his death, he was with the Bayonne Steel Casting Co., Bayonne, N. J., as construction engineer and purchasing agent.

Mr. Power became a member of the Society in 1916. He died on January 14, 1918.

THOMAS FAWCUS

Thomas Fawcus was born in April, 1866, in Bedlington, England. He was graduated from the College of Science and Art, Newcastle-on-Tyne, England. He served his apprenticeship with

Black, Hawthorne & Co., Gateshead, England, locomotive, marine and stationary-engine builders.

He came to this country in 1888, locating in Birmingham, Ala., and was associated with various manufacturing firms in the southern states until 1893. At that time he became assistant to the superintendent of the Westinghouse Electric and Manufacturing Co., Pittsburgh, Pa. About two years later he accepted the position of assistant superintendent of the steel plant of the Anderson-Dupuy Co., resigning in 1897 to become superintendent of the R. D. Nuttall Co., Pittsburgh, Pa.

Wishing to control his own business he organized and established in 1900 the Fawcus Machine Co. at Pittsburgh, manufacturing gears and special machinery and particularly herringbone-gear drives.

Mr. Fawcus was responsible for many inventions, the most notable of which are the machines for cutting herringbone gears, which he started to design and develop in 1912. These machines were patented in the United States and foreign countries.

Mr. Fawcus took an active interest in civic affairs and was a member of the Chamber of Commerce and of the Manufacturers' Association of Pittsburgh. He was also a member of the Engineers' Society of Western Pennsylvania. He became a member of our Society in 1913. He died on January 22, 1918.

ARTHUR IRVING JACOBS

Arthur I. Jacobs was born in Hebron, Conn., in 1858. His educational advantages were meager during his boyhood and after his ninth year his schooling was limited to a short period in the winter. He worked with his father in mechanical lines until he attained his majority, when he secured employment in the Knowles Loom Works, Worcester, Mass. His mechanical bent

THOMAS FAWCUS

soon displayed itself and in a short time he made great improvements in the manufacturing methods of making harness chains for looms. He remained with this firm until 1887, during which period he invented and built a book-sewing machine of which several were purchased by Boston bookbinders. The Smyth Manufacturing Co., Hartford, Conn., which also manufactured such machines, became interested in his inventions, purchased his patents and engaged him to go to Hartford and he remained with them until 1901. During this period he invented and developed several machines for bookbinding; among these were two machines for making book covers which marked a great advance over methods which had been employed.

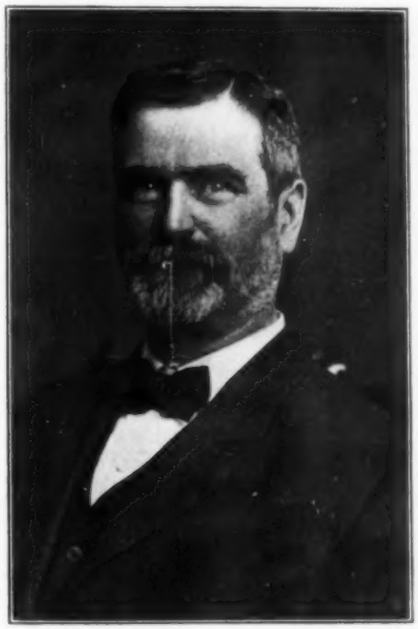
In 1902 he invented an improved drill chuck which he patented in the fall of that year. The following year the Jacobs Manufacturing Company was incorporated and has expanded from a small business to a large and active concern, of which he was president at the time of his death.

Mr. Jacobs became a member of the Society in 1913. He died on February 16, 1918.

LUIS G. MARQUINA

Luis G. Marquina was born in 1871 in Lima, Peru. He was educated in the Colegio de Guadalupe, Lima, and received his engineering degree in 1893 from the Escuela de Ingenieros, Lima.

His practical experience in general engineering was gained in



ARTHUR IRVING JACOBS

the Casapalca and Rayo Smelting Works and with the firm of Backus & Johnston. From 1893 to 1897 he was in the drafting room of the Peruvian Corporation, Ltd., at Lobos Island. From 1897 to 1902 he was with the same company as superintendent and engineer of the Pascamayo Railroad. For the next four years he was general superintendent and engineer of the Eten Railroad. About 1907 he returned to the Peruvian Corporation and at the time of his death was general superintendent and engineer of that company.

Mr. Marquina became a member of the Society in 1906. He died on June 18, 1917.

FREDERICK W. SNYDER

Frederick W. Snyder was born on June 18, 1884, in Philadelphia, Pa. He was educated in the public schools and later attended the Williamson Free School of Mechanical Trades, from which he was graduated in 1904.

Upon his graduation he was employed as machinist in the Frankford Arsenal, Philadelphia, where he remained for over a year and a half. His next position was with the Buckhorn Portland Cement Co. as draftsman, but after a brief period in this capacity he was appointed assistant mechanical engineer of the plant. In 1908 he became associated with the Baldwin Locomotive Works, Philadelphia, Pa. His work there was in the drafting room and consisted of detailing and designing electric mine locomotives. After a year and a half he resigned to take a position with the Miller Lock Co., Frankford, Philadelphia, Pa., where he designed tool-room jigs and fixtures, blanking and bending dies, etc. In April, 1910, he became an instructor in the Williamson Free School of Mechanical Trades, Delaware County, Pa. At the time of his death he had charge of the classes in strength of materials and in machine-shop practice.

Mr. Snyder became an associate-member of the Society in 1916. He died on January 29, 1918.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER MAY 10

BELOW is the list of candidates who have filed applications since the date of the last issue of THE JOURNAL. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. Total number of new applications, 256.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by May 10, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about June 15.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Arizona

RORK, CHARLES E., Chief Draftsman, Phelps Dodge Corporation, Douglas

California

CARSE, HERBERT E., Lieutenant, U. S. Naval Reserve Training Camp, San Pedro

STROMGREN, CHARLES D., Superintendent, Y. M. C. A. Automobile and Mechanical School, Los Angeles

WHITE, ERNEST M., Consulting Mechanical Engineer, Los Angeles

Colorado

NEILL, WILLIAM A., Chief Mechanical Engineer, The Dorr Co., Denver

Connecticut

BLAKESLEE, HOWARD R., Asst. Master Mechanic, The American Brass Co., Waterbury

BRAWN, ELWIN D., Designer, Bilton Machine Tool Co., Bridgeport

CUMMINS, NORMAN W., Chief Engineer and Director, The Bassick Co., Bridgeport

HANSON, HENRY, Superintendent of Machine Dept., Wilcox, Crittenden & Co., Inc., Middletown

LINABURY, JOHN E., Chief Engineer, Bristol Brass Co., Bristol

MASON-PARRY, EDMUND J., Directing Inspector, Hartford Steam Boiler Insp. & Ins. Co., Hartford

MOORE, FREDERICK T., Assistant Works Manager, Colt's Patent Fire Arms Mfg. Co., Hartford

Delaware

SHAFFER, CHARLES A., Engineer, Du Pont Nitrate Company, Wilmington

District of Columbia

GOODWIN, Percy F., Captain, Engineers, U. S. R. General Engineer Depot, U. S. Army, Washington

PORTER, MINOTT E., Principal Examiner, Steam Engines and Boilers, U. S. Patent Office, Washington

STEINMETZ, CHARLES M., Engineer, Washington

Georgia

HARRISON, NATHANIEL C., General Superintendent, Atlantic Steel Co., Atlanta

Idaho

COATES, ARTHUR B., Assistant in Mechanical Engineering, University of Idaho, Moscow

ORR, BURTON S., Associate Professor of Mechanical Engineering, University of Idaho, Moscow

Illinois

CORMACK, GEORGE, Master Mechanic, Appleton Mfg. Co., Batavia

FREDE, CHARLES F., Manager of Engineering, Commonwealth Steel Co., Granite City

KIMBALL, RAYMOND W., Boiler Room Engineer, Commonwealth Edison Co., Chicago

MOREY, WILLIAM E., Mechanical Engineer, Rodger Ballast Car Co., Chicago

RAUNICK, ERNEST J. M., Master Mechanic, By-Products Coke Corp., Chicago

STARKEY, D. W., Chief Draftsman, Griffin Wheel Co., Chicago

STOLL, CLARENCE G., Technical Superintendent, Western Electric Co., Chicago

WOODFIELD, GEORGE E., SR., Superintendent, Flottorp Mfg. Co., Chicago

Indiana

BROSSMANN, CHARLES, Consulting Engineer, Indianapolis

MARSH, HARRY B., President and Manager, Marsh Mfg. Co., Vincennes

MULLINS, THOMAS C., General Manager, Sunlight Coal Co. & Ohio Valley Coal Co., Boonville

OTT, ALBERT J., President, Ott Grinder Co., Indianapolis

ROBBINS, ELMER J., Layout work, Engineering Dept., Dodge Mfg. Co., Mishawaka

Maine

CASWELL, WILFRED H., Master Mechanic, Sandy River & Rangeley Lakes Railroad, Phillips

DELANY, EDWIN H., Naval Inspector of Machinery, Bath Iron Works, Bath

HANSON, ALBERT J., Principal Assistant Engineer, The Moulton Engineering Corp., Portland

Maryland

HUBER CHARLES J., Mechanical Engineer, The Flynn & Emrich Co., Baltimore

Massachusetts

ACHUFF, CHARLES E., Branch Manager and Sales Engineer, Mathews Gravity Carrier Co. of Ellwood City, Pa., Boston

BARTLETT, HENRY B., Chief Engineer, B. F. Perkins & Son, Inc., Holyoke

BARTON, GEORGE S., President and Treasurer, Rice, Barton & Fales M. & I. Co., Worcester

BEACH, CHARLES L., Manager, The Hoffecker Co., Boston

BENNETT, JOHN C., Works Manager, Hampden Corundum Wheel Co., Springfield

BROADHURST, FRANK S., Treasurer, Starkweather & Broadhurst, Inc., Boston

BURBANK, ALBION P. W., Sales Engineer, B. F. Sturtevant Co., Boston

COLBY, LLEWELLYN A., Inspector, General Electric Co., Pittsfield

EBELHARE, WILLIAM H., Industrial Engineering, Robert T. Pollock Co., Boston

GALUSHA, ALBERT L., In charge of Gas Producer Dept., Nelson Blowers & Furnace Co., Boston

GOULD, HENRY G., Comptroller and Director, The Graton & Knight Mfg. Co., Worcester

KNOLLMEYER, LOUIS F., Chief Inspector, General Electric Co., Pittsfield

LEWTHWAITE, ALFRED L., Mechanical Engineer, General Electric Co., Pittsfield

MEEK, ALDEN R., Sales Engineer, Westinghouse Elec. & Mfg. Co., Boston

SCANLON, EDWARD J., Chief Inspector, Boston Inspection Division, Maryland Casualty Co. of Baltimore, Md., Boston

SCHAUFUS, HUGH ALBERT, Production Manager, Metz Company, Waltham

SEWELL, HENRY R., Manager Power Apparatus Dept., B. F. Sturtevant Co., Boston

TAYLOR, CLARENCE G., Draftsman in Engineering Dept. of U. S. Armory, Springfield

Michigan

BOSTAPH, HARVEY P., Chief Engineer, Bostaph Engineering Co., Detroit

HOLDRIDGE, CLARENCE A., Factory Manager, Metalwood Mfg. Co., Detroit

KILPATRICK, WILLIAM J., Factory Manager of Burroughs Adding Machine Co., Detroit

THOMAS, GEORGE J., Chief Engineer and Superintendent, Duplex Truck Co., Lansing

Missouri

QUINN, EVERETT J., Inspector Electrical and Mechanical Engineering, Kansas City

ROBINSON, ARTHUR D., Engineer, Monsanto Chemical Works, St. Louis

SCOTT, LEWIS L., Chief Engineer, Scott Drill Company, St. Louis

Nebraska

RASMUSEN,, JESSE E., Associate Professor, University of Nebraska, Lincoln

New Jersey

ENKE, GEORGE P., Insurance Engineer, James E. Garabrant & Co., Newark

GARSON, THORVALD N., Superintendent of Construction, The Singer Manufacturing Co., Elizabethport

RUSS, CHARLES W., Manager, Armstrong Cork Co., Camden Plant, Camden

WICKHAM, JAMES S., General Foreman, Crucible Steel Co. of America, Ordnance Dept., Harrison

New York

BARNUM, E. S., Editorial Work, G. M. Basford Company, New York
BENDURE, JAMES A., Sales Engineer, American District Steam Co., N. Tonawanda
COOK, SAMUEL, Air Brake Foreman, Van Nest Elec. Shops, N. Y., N. H. & R. R. R. Co., Van Nest, New York
DENISON, GRISWOLD, Engineer, Moses, Pope & Trainer, Inc., New York
DORNIN, ALEXANDER L., Engineer, Theo. E. Ferris, New York
EBY, EARL E., Asst. Manager, Industrial Bearings Div., Hyatt Roller Bearing Co., New York
ELLIOT, JAMES A., Assistant Engineer, Mathieson Alkali Works, Inc., Niagara Falls
FLECKENSTEIN, ALFRED C., Office Manager and Cost Accountant, Richmond Radiator Co., New York
FLEISHER, WALTER L., President, W. L. Fleisher & Co., Inc., New York
GRONBECH, CHRISTIAN E. A., Superintendent & Assistant Factory Manager, C. J. Tagliabue Mfg. Co., Brooklyn
HARD, MALCOLM, Mechanical Engineer, Nathan Manufacturing Co., Flushing, New York
HARRISON, GEORGE C., Industrial Engineer and Chartered Accountant, New York
HAVENS, WILLIAM W., Assistant Engineer, Liquid Air Division, Engineering Dept., Air Nitrates Corporation, New York
HELMER, NICHOLAS A., Consulting Engineer, Miranda Sugar Co., New York
HOOVER, A. PEARSON, Consulting Engineer, Goodrich, Hoover & Bennett, New York
HOPKINS, WILLIAM P., With C. E. Knoeppel & Co., New York
JENSEN, ARTHUR R., Instructor of Physics and Applied Electricity, Hebrew Technical Inst., New York
KIRSCH, GEORGE H., Member Committee of Examiners, Naval Consulting Board, New York
LATTING, JOHN W., Farming, Werah Farms, Inc., Locust Valley
MORROW, ALEXANDER P., President and Manager, Willys-Morrow Co., Elmira
NORDFORS, CONRAD, Contracting Engineer, Wood Newspaper Machinery Corp., New York
OLSON, HAROLD M., Mechanical Engineer, The Permutit Co., New York
O'ROURKE, GEORGE A., Chief Engineer, State Industrial Commission, Bureau of Boilers & Explosives, Albany
PAGE JULIAN D., Chief Draftsman, Perin & Marshall, New York
RANK, HOMER L., Asst. Manager, New York Office, Mead-Morrison Mfg. Co. of Boston, New York
ROTHWELL, COURTENAY R., President, Plant Engineering and Equipment Co., New York
RYTHER, GEORGE D., President, Ryther & Pringle Company, Carthage
SCHUYLER, LESLIE J., Production Manager, Porter-Cable Machine Co., Syracuse
SHOREY, JOHN A., Engineer Specialist, General Electric Co., New York
UEHLING, F. F., Combustion Engineer, also General Manager Uehling Instrument Co., New York
UPDIKE, DAVID M., Assistant Superintendent, Department of Buildings and Grounds, Columbia University, New York

Ohio

JOHANNESMEYER, CHARLES G., Chief Mechanical Engineer, The Liberty Machine Tool Co., Hamilton
KAARBO, AGNAR, Mechanical Engineer, Hydraulic Pressed Steel Co., Cleveland
KAHN, BERTRAND B., Works Engineer, The Estate Stove Co., Hamilton
PEARSON, MORRIS A., Chief Engineer, Turner Vaughn & Taylor Co., Cuyahoga Falls
SPARKS, A. F., General Manager and Chief Engineer, The James Leffel & Co., Springfield
TOWNSEND, THEODORE A., Chief Draftsman, McGraw Fire & Rubber Co., East Palestine
WITKER, CHARLES J., Mechanical Engineer, Baker Brothers, Toledo

Oklahoma

DRYDEN, RAYMOND P., Draftsman, Gosden & Co., West Tulsa

Pennsylvania

CAMPBELL, JAMES R., Mechanical Engineer, Baldwin Locomotive Works, Philadelphia
FOLTZ, THOMAS F., Mechanical Engineer, Pennsylvania Dept. of Labor & Industry, Harrisburg
GEE, NORMAN E., Assistant Foreman, Pennsylvania Railroad, M. E. Office, Altoona
GROAT, BENJAMIN F., Consulting Engineer, Pittsburgh
GROW, JOSEPH A., Mechanical Engineer, Blaisdell Machinery Co., Bradford
HARRIS, EDSON S., President, Philadelphia Steel Products Co., Philadelphia
HOOD, MARVIN C., Manager Employment Department, Chester Shipbuilding Co., Chester
JOHNSON, JOHN B., Superintendent of Power and Machinery Erection, Wm. Gordon Corp., Bristol
LARKIN, WILLIAM H., JR., Assistant Manager and Treasurer, Larkin & Co., Butler
MIKAELSON, ERIL W., Chief Engineer, Treadwell Engineering Co., Easton
RUSH, LEO E., Planning and Production Engineer, Bethlehem Steel Co., Bethlehem
SCHMID, WERNER E., Mechanical Engineer, Dravo-Doyle Co., Pittsburgh
SKINKLE, WILLIAM B., Assistant Chief Mechanical Engineer, Homestead Steel Works of Carnegie Steel Co., McKees Rocks
STAMETS, WILLIAM K., Machine Tool Dealer, Pittsburgh
STEVENSON, ARTHUR J., Watch Engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh
STUDLEY, GIDEON, JR., Engineer, Condenser Dept., Westinghouse Elec. & Mfg. Co., Machine Works, East Pittsburgh
THOMPSON, JOHN I., Chief Engineer, The Koppers Co., Pittsburgh

Rhode Island

FLICK, LORENZ, Experimental Engineer at Sayles Finishing Plants, Saylesville
HIRD, GEORGE W., Foreman, Tool Department, Woonsocket Machine & Press Co., Woonsocket
TILLINGHAST, WALLACE E., Managing Owner of the Mass. Steam Specialty Co., Auburn

Tennessee

MURRIAN, WILLIAM S., Superintendent of Motive Power, Southern Ry., Knoxville

Texas

GLASGOW, JOHN B., Assistant Construction Engineer, Gulf Refining Co., Port Arthur

Utah

SECKELS, LOUIS J., Engineering Salesman, F. C. Richmond Machinery Co., Salt Lake City

Virginia

HAMMERSTROM, WILLIAM G., General Superintendent, Lynchburg Foundry Co., Lynchburg

Vermont

PAINE, WALTER H., Master Mechanic, Boutwell, Milne & Varnum Co., Graniteville

Wisconsin

BAIR, EDWARD H., Consulting and Sales Engineer, Fairbanks-Morse Co., Milwaukee

Canada

CANTELL, MARK T., Consulting Engineer, Winnipeg
NORRIS, EDWIN R., Master Mechanic, Algoma Steel Corporation, Sault Ste. Marie
WHITE, ALBERT F., General Superintendent, Marsh & Henthorn, Belleville, Ontario

Canal Zone

AUTEN, WILLIAM J., Mechanical Engineer, Mechanical Div. P.C., Balboa

Cuba

SNODGRASS, WILLIAM, Engineer, Honolulu Iron Works Co., Havana
WATERMAN, HENRY J., Chief Engineer, Central Stewart, Cuba Cane Sugar Corp., Stewart, Camaguey

Hawaii

McKAY, WILLIAM, Marine Superintendent, Inter Island Steam Navigation Co., Ltd., Honolulu
SIMPSON, ALFRED M., Superintendent, Honolulu Iron Works Co., Honolulu

Japan

HIRANO, T., Adviser of Kobe Steel Works, Kobe

Scotland

GIBSON, ARNOLD H., University Professor of Engineering, University of St. Andrews, Dundee

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

Alabama

FEAR, FRANK G., Draftsman, Tennessee Coal Iron & R. R. Co., Ensley

Arizona

DUNNING, CHARLES H., Manager, Big Pine Consolidated Mining Co., Prescott

California

BLANCHARD, WALTER J., Assistant Chief Engineer, California & Hawaiian Sugar Refining Co., Crockett

Connecticut

BUCHANAN, WILLIAM C., Superintendent, Steel Works, Rolling Mills, American Tube & Stamping Co., Bridgeport
HONIG, FRANK, Designer of Special Machinery, The Bristol Brass Co., Bristol
MADDISON, WALTER F., Instructor, State Trade Education Shop, Bridgeport

District of Columbia

KARTSHER, HARRY S., Gage Designer, Engineering Bureau, U. S. Ordnance Dept.,

Massachusetts

KING, VERNON C., Chief Draftsman, Spencer Wire Co., Worcester
POLLEY, ALVIN H., Chief Draftsman, Brown Engine & Machine Co., Fitchburg

Minnesota

THAYER, PAUL W., Mechanical Engineer, Williams Bros. Boiler & Mfg. Co., Minneapolis

Missouri

GEORGE, RALPH D., Assistant Engineer, E. M. Stevens & Co., Consulting Engineers, Kansas City

New Jersey

FRAMBACH, FREDERICK S., Sales Engineer, Hyatt Roller Bearing Co., Newark

SLEEPER, WILLIAM A., Assistant to President, Brighton Mills, Passaic

New York

BENSAMON, EDMOND, Manager Refining Plant, American Chicle Co., Long Island City

MIANO, NICHOLAS J., Mechanical Engineer, Universal Fixture Corp., New York

POSTNIKOFF, ALEXANDER A., Chief Inspector Russian Mission of Ways of Communication, New York

WALTERS, V. EDGAR, Night Superintendent Savage Arms Corp., Utica

Ohio

McGILL, MINTO, Draftsman, The Alliance Machine Co., Alliance

Rhode Island

FOLEY, PATRICK H., Foreman, C. B. Cottrell & Sons Co., Westerly

Canada

BARRETT, KARL E., Superintendent and Chief Engineer, E. & T. Fairbanks, Ltd., Sherbrooke

FOZARD, LEONARD G., Master Mechanic, The Marconi Wireless Telegraph Co., Montreal

JOYCE, WALTER E., Engineer of Design, Mount Royal Tunnel & Terminal Co., Ltd., Montreal

MURPHY, PETER, Chief Draftsman, Marconi Wireless Telegraph Co., Montreal

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

California

DOYLE, FREDERICK F., Engineer, Midway Gas Co., Taft

Colorado

MILLER, ALBERT F., Designing Engineer, Peters Machinery Co., Denver

Connecticut

BUCHANAN, DAVID D., Night Superintendent, American Tube & Stamping Co., Bridgeport

COFFIN, GRANGE S., Mechanical Engineer, Remington Arms U. M. C. Co., Bridgeport

WEIDER, ARTHUR A., Installation, Industrial Engineering Staff, Winchester Repeating Arms Co., New Haven

Delaware

SCHNEIDER, FRANZ K., Assistant Chief Engineer, The Krevs Pigment & Chemical Co., Newport

District of Columbia

CHAPIN, WILLIAM C., Assistant Inspector Weights and Measures, Bureau of Standards

HEDSTROM, ERNEST R., Lieutenant, Engineering Bureau, U. S. Ordnance Dept.

WEISS, ERWIN A., Ordnance Sergeant, Engineering Bureau, Motor Section,

Indiana

HUFF, AARON B., Special Apprentice, Pennsylvania R. R. Co., Fort Wayne

Maryland

RYLANDER, PAUL N., Aeroplane Inspector, U. S. Navy, Baltimore

Massachusetts

CARTER, IRVING E., Machinist Mate 2nd Class, U. S., Naval Reserve, District No. 1, Boston

FOISY, GEORGE A., Designing Engineer, U. S. Cartridge Co., Lowell

PAINCHAUD, PHILLIP A., Inspector of Ordnance, U. S. Army, C. H. Cowdrey Machine Works, Fitchburg

PRATT, WINTHROP S., Manufacturing Manager, Heald Machine Co., Greendale

SMITH, RAYMOND E., Assistant Engineer and Draftsman, Springfield Armory, Springfield

SPARROW, STANWOOD W., Mechanical Engineer, Robert T. Pollock Co., Boston

Michigan

HOLMBERG, ABNER W., Instructor Foundry Practice, Ironwood High School, Ironwood

Missouri

JOHNSEN, PEDER, Mechanical Engineer, Missouri Cobalt Co., Fredericktown

New Jersey

ACKERMANN, WILLIAM H., Mechanical and Production Engineer, Bayonne Bolt & Nut Co., Bayonne

KOHLBUSCH, ARTHUR H., Assistant Superintendent Construction, Public Service Electric Co., Newark

New York

CASE, LYNN B., Chief Engineer, Standard Wall Paper Co., Hudson Falls

LEWIS, WILLIAM J., Jr., Assistant Manager Engineering Department, Shipley Construction & Supply Co., Brooklyn

McINTYRE, JAMES J., Publicity Engineer, Machinery, New York

NEEL, ROBERT W., Chief Engineer, Erie Pump & Engine Works, Medina

OSMENA, MARIANO, Draftsman, Combustion Engineering Corp., New York

PULSCHEN, HENRY G., Draftsman, J. G. White Engineering Corp., New York

RABBE, HELLIK, Draftsman, Kerr Turbine Co., Wellsville

RIDDLE, GEORGE G., Engineering Department, Ingersoll-Rand Co., Painted Post

SYSKA, ADOLPH G., Assistant Engineer, New York Central R. R., New York

SWAIN, WILBUR A., Salesman, Jenkins Bros., New York

Pennsylvania

DOWNS, LESLIE B., Assistant Chief Engineer, Epping-Carpenter Pump Co., Pittsburgh

FISHER, HERMAN A., Assistant to Plant Engineer, Chester Shipbuilding Co., Chester

GUTEKUNST, LEONARD, Mechanical Engineer, De Long Hook & Eye Co., Philadelphia

KEENAN, WILLIAM J., Draftsman, American International Shipbuilding Corp., Philadelphia

KIRKPATRICK, W. ALTON, C. H. Wheeler Mfg. Co., Philadelphia

KOHN, LOUIS, Mechanical Engineer, Dravo Contracting Co., Pittsburgh

MORGAN, DAVID W. R., Engineer, Condenser Department, Westinghouse Elec. & Mfg. Co., E. Pittsburgh

PRINGLE, HARRY C., Master Mechanic, Franklin Works, Cambria Steel Co., Johnstown

SENIOR, JOHN H., Sales Engineer, Smith & Furbush Machine Co., Philadelphia

Rhode Island

SHERWIN, LEROY M., Mechanical Engineer, Brown & Sharpe Mfg. Co., Providence

Virginia

HORNE, CALEB L., Boiler Engineer, E. I. du Pont de Nemours & Co., City Point

Washington

TRACK, FRANK A., Naval Architect & Marine Engineer, Sanderson & Porter, Shipyard, Raymond

FOR CONSIDERATION AS JUNIOR

Connecticut

BUTLER, FRANK T., with 19th Engineers, U. S. Army, formerly with The Bristol Co., Waterbury

HORGAN, DANIEL F., Naval Sub-Inspector of Ordnance, Office of Naval Inspector of Ordnance, Bridgeport

McCARTY, ROBERT P., Tool Designer, Colt's Patent Fire Arms Mfg. Co., Hartford

Delaware

BENST, CECIL J., Engineering Draftsman, E. I. du Pont de Nemours & Co., Wilmington

DOAR, E. MARION, Jr., Draftsman, Engineering Department, E. I. du Pont de Nemours & Co., Wilmington

Illinois

DUNDAS, WILLIAM A., Field Engineer, Sherwin, Williams Co., Chicago

VAN DEVENTER, FRANK M., Assistant Operating Engineer, Illinois Traction System, Peoria

Louisiana

MITCHELL, GROVER I., Instructor, Louisiana Industrial Institute, Ruston

Maryland

STIERHOFF, GEORGE C., Engine Designer and Power Engineer, Riter-Conley Mfg. Co., Fairfield

Massachusetts

BEATTIE, CHALLEN M., Mechanical Draftsman, Bethlehem Shipbuilding Corp., Ltd., Fore River Plant, Quincy

MENDELSOHN, LOUIS E., Engineer, Western Electric Co., Inc., Boston

Michigan

CAMERON, HUGH M., Chief Engine Draftsman, Saginaw Shipbuilding Co., Saginaw

Minnesota

ABERNETHY, ALFRED A., Designer, Minneapolis Steel & Machinery Co., Minneapolis

Missouri

ANGEVINE, LELAND C., Superintendent Hydroelectric Plant, Burns & McDonnell, Kansas City

ROYSE, IRAM O., Instructor in Machine Drafting, David Ranken, Jr., School of Mechanical Trades, St. Louis

New Hampshire

CHICK, GEORGE E., Partner, John F. Chick & Son, Lumber Manufacturers, Silver Lake

GRAY, FRANK A., Purchasing Agent, The Lebanon Machine Co., Lebanon

New Jersey

KING, WARREN G., with Aeromarine Plane & Motor Co., Keyport

OBERLE, JOHN H., Checker and Contract Analyzer, Babcock & Wilcox Co., Bayonne

ROTHOWITZ, HARRY S., Production Engineer, Babcock & Wilcox Co., Bayonne

RUSCH, OLAF, Designer, Babcock & Wilcox Co., Bayonne.

New York

BOIES, HARRY B., Inspector of Airplanes and Airplane Engines, Signal Service at Large, Buffalo

BROOKS, FREDERICK A., Airplane Designer, Curtiss Aeroplane & Motor Corp., Buffalo
CONWAY, JOHN J., Testing Engineer, Alberger Pump & Condenser Co., Newburgh
DANKS, ROY L., Time Study Engineer, Winchester Repeating Arms Co., New York
DUNN, WILLIAM K., Long Lines Engineering Dept., American Telephone & Telegraph Co., New York
GOSSELIN, EDWARD N., Industrial Engineer, Miller, Franklin, Basset & Co., New York
HAUSER, GEORGE H., Jr., Junior Engineer, The Arnold Co., Brooklyn
HILL, HERBERT M., Manager, United States Machine Mfg. Co., New York
MORGAN, ALBERT H., Engineering Assistant, Western Union Telegraph Co., New York
NAUMANN, CARL, Factory Representative, Hannifin Mfg. Co., Syracuse
PERKINS, DONALD L., Leading Man, Federal Shipbuilding Co., New York
RUNYON, HOWARD J., Jr., Sales Engineer, United Filters Corp., Brooklyn
SCHLEIFER, ARTHUR, Assistant Engineer, Interborough Rapid Transit Co., New York
STAMER, FRANK R., Senior Student Mechanical Engineering, Brooklyn Polytechnic Institute, and Assistant to Dr. A. A. Adler, Consulting Engineer, Brooklyn
TUOMEY, THOMAS D., Secretary and Manager, Sanitary Mechanical Specialty Co., New York

Ohio

ALLISON, JOHN R., 2nd Lieutenant, Engineer Reserve Corps, U. S. Army, Cleveland
CHASE, VERNON B., Sales Engineer, The Acklin Stamping Co., Toledo
PHILPOT, NORBOURN E., Testing Engineer, The Youngstown Sheet & Tube Co., Youngstown
ROGERS, J. FRANK, Engineer in Charge Gas Producer & Furnace Dept., The Wellman-Seaver-Morgan Co., Cleveland
SPRONG, EDWARD A., Jr., Head of Production Department, Niles Tool Works, Hamilton

Pennsylvania

FLYNN, JAMES A., Production Engineer, Blaw-Knox Co., Pittsburgh
HARTSIG, EMORY R., Assistant to Resident Engineer, U. S. Shipping Board, Hog Island, Philadelphia
HENDEE, ROBERT W., Engineer, Midvale Steel & Ordnance Co., Nicetown, Philadelphia

Vermont

JOHNSON, JOSEPH B., Chief Engineer, Bryant Chucking Grinder Co., Springfield

Virginia

SMITH, LEWIS M., Radio Draftsman, U. S. Navy Yard, Norfolk

Wisconsin

SEUTTER, LOUIS, Assistant Engineer in Forest Products, U. S. Dept. of Agri., Forest Service, Forest Products Laboratory, Madison

Canada

HIGGINSON, RICHARD H., Superintendent, Monarch Brass Mfg. Co., Ltd., Toronto
LEWIS, DONALD, Chief Draftsman, Nova Scotia Steel & Coal Co., Ltd., New Glasgow, N. S.

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

Massachusetts

CHAPMAN, DAVID A., Vice-President, The Dangel Co., Winthrop

New York

DIVINE, BRADFORD H., President, Divine Brothers Co., Utica

PROMOTION FROM ASSOCIATE-MEMBER

Illinois

MAHER, EUGENE E., Contracting Engineer, Lea-Courtenay Co., Chicago

Michigan

ANTON, JAMES E., Assistant Manager of Mfg., Cadillac Motor Car Co., Detroit

Ohio

GRISWOLD, HOWARD L., Consulting Engineer, Standard Bolt Co., Columbus

Canada

GAINES, EDWARD C., Engineer, Dominion Bridge Co., Montreal

PROMOTION FROM JUNIOR

District of Columbia

COOMBS, HOWARD A., Patent Attorney.

Georgia

O'BRIEN, DENNIS J., Mechanical Expert, Galena-Signal Oil Co., Atlanta

Michigan

GLENN, CHARLES C., Engineer, Detroit Plant, The Solvay Process Co. (Reinstatement). Detroit

New York

GOALWIN, HARRY A., Medico-Technical Engineer, New York
HENRY, WILLIAM M., Treasurer and Works Manager, Henry & Allen, Auburn
YOUNGBLUTH, R. O., Managing Engineer, Architectural Department, American Radiator Co., New York

Pennsylvania

GLENN, EDWARD R., Production Officer, Bethlehem Steel Co., Bethlehem
KENNER, ERNEST R., Mechanical Engineer, Westinghouse Elec. & Mfg. Co., Pittsburgh

SUMMARY

New applications	256
Applications for change of grading:	
Promotion from Associate	2
Promotion from Associate-Member	4
Promotion from Junior	8
Total	270

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping any one desiring engineering services. The Society acts only as a clearing house in these matters.

IN forwarding applications, stamps should be enclosed for transmittal to advertisers; applications of non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society. Copy for The Journal should be in by the twelfth of the month.

GOVERNMENT REQUESTS

AEROPLANE AND MOTOR CORPORATION has available a number of attractive opportunities for technically trained men as equipment, production, maintenance and woodworking engineers, and as high-grade tool and die designers. Younger men are also wanted for planning and routing work in premium department. 2589.

INSPECTORS of airplane metal and wood parts, assemblies, propellers; must be able to read blueprints and use simple instruments.

Inspectors of airplane motors with knowledge of methods of heat-treatment of metals and machine-shop or tool-room experience, preferably on engine parts.

Inspectors of electrical material. Salaries for these civilian positions at the beginning will be from $1200 to $1500 per annum. 2591.

COMMISSIONED OR CIVILIAN SERVICE. Research and development men to bring to stage of commercial production parts made of sheet metal, fabrics, rubber and die castings. Applicants must have personality to secure coöperation of manufacturers in development work along the above lines. Salary $2000 to $2500. 2592.

POSITIONS AVAILABLE

ESTIMATOR for boiler and tank work, gray-iron castings and some machine-shop work. Requires a man of stability and experience. Technical education preferred. Location Buffalo, N. Y. 089-D.

MECHANICAL DRAFTSMAN for general factory work to lay out work of a general character. Familiar with power-plant, steam-heating and electrical equipment. Good opportunity for advancement for right kind of man. Location Newark, N. J. 092-D.

ENGINEERS for Asiatic service, men above draft age up to 37, preferably unmarried but will consider married men. Men with mechanical, electrical, or chemical engineering education, preferably with sales experience. Salary $2000 or more, depending upon ability and experience. 097-D.

TECHNICAL GRADUATE or mechanical engineer for office work in connection with power plants with large manufacturing concern in Western Pennsylvania. Salary at

start $1500. State particulars of education, nationality and experience. 099-D.

TECHNICAL GRADUATE or mechanical engineer to enter engineering organization of large stoker company in Western Pennsylvania. Man specialized in combustion science and boiler-testing work preferred. State particulars of education, experience, nationality and salary desired. Good opportunity for right man. 0100-D.

CHIEF DRAFTSMAN for large stoker company in Western Pennsylvania. Must be a good designer. Man with experience on stoker work preferred. Good opening for a capable and energetic man. Write stating nationality, age, education, experience, present responsibility and salary expected. 0101-D.

JUNIOR ENGINEER, familiar with heat-transfer calculation, in the engineering department of a large steam-specialty manufacturing concern. A graduate engineer with at least two years' outside experience is desired. Location New York. 0102-D.

YOUNG TECHNICAL MAN to assist in sales correspondence and experimental work, primarily as assistant to executive. Prefer man recently graduated from technical school and exempt from military service. Excellent opportunity for growth. Location New York. 013-D.

GRADUATE of technical school with some machine-shop experience and not subject to draft, as assistant to engineer of sales department located in metropolitan district. Excellent opportunity for the right man. Apply by letter, giving full particulars. 0104-D.

MECHANICAL DRAFTSMAN in New York office, preferably one versed in mechanical refrigeration and electrical engineering. 0109-D.

TOOL DESIGNER capable of designing efficient tools for engine manufacture along modern lines. Salary from $100 to $150 a month according to ability. Location Wisconsin. 0110-D.

DESIGNER on outside installation of piping, electric lines and heating mains. Technical graduate preferred. Salary depends on ability. 0111-D.

INSPECTOR on outside installation of piping, electric lines and heating mains. Technical graduate preferred. Salary depends on man. 0112-D.

ENERGETIC YOUNG MECHANICAL ENGINEER, exempt from draft, with sales ability, as business developer for an engineering company of New York City specializing in the operation of power plants in buildings. Good salary and share in profits given to the right man. State present salary and qualifications. 0113-D.

SALES MANAGER AND EXECUTIVE to manage long-established, small but high-class and prosperous business in electrical measuring instruments. Must have sales experience, good personality and proven selling ability. Good immediate remuneration and ultimate stock interest to right party. Location New York. 0115-D.

YOUNG MEN, preferably exempt from draft, to train as engineers and salesmen. Preferably technical graduates, bright, alert and of analytic frame of mind. Salary depends on men. Location Massachusetts. 0116-D.

DRAFTSMEN. Two technical-graduate mechanical engineers with 6 to 12 months' experience in general mechanical drafting in an industrial plant. Advise salary expected. Location New York State. 0117-D.

SUPERINTENDENT experienced in general machine-shop practice and of good executive ability for shops employing 600 and 700 men. Location Ohio. 0119-D.

POWER ENGINEER experienced in public-service corporation or in power department of large industrial corporation, thoroughly familiar with costs, the economics of power and the technique of power transmission and generation. Man of strong personality who can grow. Require from six to eight years' practical experience after technical training. 0120-D.

SUPERINTENDENT for moderate-sized machine shop making small stampings and cast brass parts. Man with unquestionable record required. Send complete past experience with names of companies where employed and position held with each. Want man experienced in economical manufacture of small parts in quantities and well versed in modern economical production. Location Michigan. 0121-D.

MEN to take charge of construction of marine engines for which contracts have been let to small concern. Location Erie, Pa. 0123-D.

SALESMAN on railway, mining and electrical equipment. Experienced man over 31 required. Knowledge of French preferred. Salary depends on man. Headquarters in China. 0124-D.

MECHANICAL ENGINEER to take charge of engineering department of large paper mill. Man with a technical education and a successful record in the operation and maintenance of power plants and factories and also the handling of men. State age, experience and salary expected. Location Eastern Pennsylvania. 0126-D.

MECHANICAL DRAFTSMAN familiar with mill and machinery design for metallurgical and chemical plants. Advise experience, salary expected and references. Location Colorado. 0127-D.

SALES ENGINEERS for leading manufacturing concern. Men who can sell power-plant and engineering equipment, engines, pumps, air compressors, condensers, etc. An opportunity for men of character and ability. Must be draft-exempt or in Class 4. Give full details, age, education, experience, reference and salary. Location New York. 0128-D.

ENGINEERS to train and develop in the fundamentals of a firm primarily engaged in the distillation of coal tar with the resultant principal production of bituminous road and roofing materials; with the ultimate object of filling operating positions in various plants as foremen, head chemists, assistant superintendents or superintendents. Preferably men of chemical-engineering training desired, but this is not essential. As contemplated work will eventually be of an executive nature; ability to handle men is a desirable asset. Location New York. 0129-D.

SEVERAL EXCEPTIONAL OPPORTUNITIES for permanent positions, both technical and operating, in a plant making a full line of non-ferrous metal products. Work now almost entirely on government orders. Location desirable. 0131-D.

DRAFTSMAN on structural and ornamental iron work. Prefer technical man experienced in shop detail. Permanent position. Location Kansas. 0132-D.

MECHANICAL ENGINEERS experienced in construction work or design for chemical plant. State experience in detail and salary expected. Location Philadelphia, Pa. 0134-D.

MACHINE-SHOP SUPERINTENDENT for small concern manufacturing interchangeable parts and automatic machinery. Technical graduate with five or six years' experience preferred. Must be above the draft age. Salary $2500-$3000. Location Illinois. 0135-D.

DRAFTSMAN familiar with boiler construction and design. Give age, experience and salary. Location Chicago. 0138-D.

MASTER MECHANIC experienced in handling machinists, pipe fitters, electricians, millwrights and tinsmiths, familiar with conveying machinery, pumps, lineshaft drives, etc. Prefer practical man who has worked in a mill. Salary commensurate with ability. Location New Jersey. 0139-D.

CONSTRUCTION ENGINEER, for work principally on power-plant machinery. Location Shanghai, China. 0140-D.

SALES ENGINEER familiar with heavy-duty crude-oil semi-Diesel marine engines. Position in the foreign office, Manila. 0141-D.

COMPETENT MAN on flue-gas analysis and power-plant fuel work. Generally good opening for the right man. Technical graduate preferred, but not absolutely required. Location Ohio. 0142-D.

SALES ENGINEER. High-grade, experienced, energetic salesman to take charge of district sales office and territory; only a hustling good salesman is desired. Technical education with experience in conveying machinery preferred, but not essential. Exceptionally fine opportunity offered. Please state full particulars of experience, age, previous employment, salary expected, etc. 0145-D.

ENGINEER thoroughly capable of selecting and installing machinery for the manufacture of steel files for a factory, and supervising manufacture after factory shall have been completed. Should be thoroughly familiar with the various processes of file manufacture. Location East. 0146-D.

OFFICE ASSISTANT. Man between 21 and 35 with knowledge of machinery, preferably with previous experience in tools and machines for sheet metals, to assist in general correspondence. State age and experience. Location Buffalo, N. Y. 0148-D.

GENERAL FOREMAN AND SHOP MAN for plant in New York State for superheaters. Man with foundry and general shop experience preferred. Apply by letter. 0153-D.

FOREMAN for small shop in New York City. Must be well informed on mechanics and able to standardize flash lamps and blow lamps. Business established over 50 years and has promise of a good future. Good opportunity for a technical graduate ambitious to prove his worth. Must be an all-round man. Salary to start $1200. Name confidential. 0157-D.

CHIEF DRAFTSMAN. Draftsman experienced in maps, broad and narrow-gage railroads, frame buildings, layout of equipment and the design of special machinery. Com-

pany will take care of U. S. Government orders entirely. It is a chance to do your bit. A man of ability will be given early recognition and a permanent position. Apply by letter, stating age, nationality, experience, references and salary desired. Location Pennsylvania. 0158-D.

SALES MANAGER for power-plant specialty business. Reply by letter. Location Pennsylvania. 0159-D.

ASSISTANT TO GENERAL MANAGER for large mill in New Hampshire. Man between 32 and 45 preferred who has had experience with the installation of scientific-management methods. Must be able to handle tactfully executives and employees. State salary, when available, and give references. 0160-D.

FACTORY SUPERINTENDENT. Prominent manufacturing corporation manufacturing light product of large variety—part stock, part special to order—requires aggressive, energetic factory superintendent thoroughly experienced in machine-shop practice and modern centralized planning control methods, capable of securing large production most efficiently and economically. To be considered, replies must fully state experience and qualifications. 0161-D.

ASSISTANT CHIEF ENGINEER. Graduate from technical college who is a good organizer and executive and capable of directing mechanical, civil and electrical forces of large manufacturing corporation. Must have considerable experience similar to above to qualify. Man 32 to 40 years old preferred. State full details of education, names of previous employers, positions held and salary desired. Location Cleveland, Ohio. 0162-D.

TECHNICAL GRADUATE for material department of firm handling all types of machinery. Purchasing and statistical experience desired. Salary to start $150 to $175, with excellent chance for advancement. Location New York. 0163-D.

SALES MANAGER. Engineer experienced in estimating and selling to hold responsible position in long-established engineering and contracting business of an incorporated company. Possible opportunity to become financially interested. Give age and experience in reply. 017-D.

SALES ENGINEER between 25 and 30 for condenser and cooling plants. State experience, salary expected, and give references. Location Philadelphia, Pa. 072-D.

SALES CORRESPONDENT. Engineering and correspondence experience such as involved in formulating proposals covering sale and calculation in steam and power-driven pumping equipment, including application of steam engines, and electrical equipment that may be employed. Applicant should supply references bearing upon a record as correspondent, closing of contracts, execution of orders and closing of accounts. Location New Jersey. 093-D.

DESIGNER for machine shop. Location Ohio. 0118-D.

ONE MECHANICAL AND ONE ELECTRICAL ENGINEER, preferably married men without children and willing to take positions at sulphur-refining factories at Marseilles and Cette, France. 2052-D.

RAPID DETAIL DRAFTSMEN AND DESIGNERS on electric furnaces, gas producers, heavy machinery for steel-plant and coke-oven equipment, coal- and ore-handling equipment and complicated structural details. Location Cleveland, Ohio. 2061-D.

TOOLMAKERS AND TOOL DESIGNERS experienced on jigs, fixtures and gages. Only first-class men need apply. Good wages and best of working conditions. 2155-D.

JUNIOR SALES ENGINEER, preferably engineering graduate with selling experience. Must be familiar with steam-specialty apparatus. Location New York. 2158-D.

DESIGNER of power-plant work. College graduate preferred. Salary $125-$180 according to man. Location New York. 2162-D.

CHIEF DRAFTSMAN to take charge of a dozen men and experienced in design of tools, jigs, and fixtures. Prefer a man from 25 to 35 years with shop experience in the manufacture of interchangeable parts and with executive ability so that he can assist the superintendent directing the technical work. Salary $200 to $250 per month to start. 2200-D.

COLLEGE GRADUATES, ENGINEERS. Men out at least a year for general shop-engineering work with growing concern. Work leads to industrial management. State full particulars. Location New Jersey. 2478-D.

MASTER MECHANIC for large central power plant. Permanent position with chance for advancement. State age, experience, salary expected and position regarding draft. 04-D.

HEATING AND VENTILATING ENGINEER to supervise design, installation and work in advisory capacity in connection with maintenance in large rubber factory in northern Ohio. Salary commensurate with training, experience, and ability to handle men. Splendid opportunity for the right man. 2561-D.

APPRAISAL ENGINEER experienced in appraisals of industrial properties. Technical man preferred. Location at start in New York and later to have charge of branch office in large Middle West city. State experience, age and salary expected. 0164-D.

INVENTORY AND APPRAISAL DEPARTMENT ENGINEER for one of the Eastern State commissions; man with technical training as mechanical engineer, and with one year or more of experience in engineering work preferred. Some knowledge of accounting and of appraisal work desirable but not essential. Present engineering staff is small; good opportunity for advancement for the right man. Location Newark. 0168-D.

INSTRUCTOR in elementary mathematics and mechanical drawing for Apprenticeship School. Candidates should have had some technical training and shop experience and should understand the handling of young men. Position offers excellent opportunities for advancement in the works and will pay an initial salary of $1200 or more per year, according to the caliber of the man. Location Connecticut. 0176-D.

MEN AVAILABLE

ASSISTANT to the president or general manager of a manufacturing corporation is a connection desired by a competent industrial engineer, age 32. Graduate engineer and accountant, engaged two years in construction and design and seven years as consultant in industrial operation. Experienced in wide range of industries, including textile, machinery, foundry and steel. Wishes now to obtain settled address. Offers convincing references. D-85.

TECHNICAL GRADUATE, associate-member, age 33, with over 10 years' experience in planning, design, erection and operation of power-plant and manufacturing equipment, desires new connection as mechanical engineer or in other executive capacity for which his ability and experience would qualify him. Complete record with best of references on request. Location preferred Pacific Coast States. D-86.

PRODUCTION MANAGER experienced on aeronautical engines and parts and high production on light-weight machinery desires position as executive on Government work. Expert tool designer; experience in shop efficiency and cost recording; understands all classes of automatic machine work, including sheet-metal stamping. Salary about $300 a month. D-87.

MECHANICAL ENGINEER AND EXECUTIVE, age 30, at present in charge of engineering department of large manufacturing concern. Good on automatic-machinery, jig, die and tool design, for interchangeable manufacture. Practical shop man who can supervise work from drawing room to completion, and is an expert on factory layouts and equipment. Salary $2500 to $3000. D-88.

EXECUTIVE SALES ENGINEER now holding responsible position for five years as sales manager desires similar position with company having larger field. Has traveled extensively and is well acquainted with automobile and machine manufacture. Graduate mechanical engineer, good executive, and of pleasing personality; alert and resourceful, and exercises well-balanced judgment in all propositions. D-89.

MECHANICAL ENGINEER, age 44, with 12 years' manufacturing experience, desires a change. Expert in the design of special machinery for economical production, making investigations and experiments, and following work through to completion. Resourceful, tactful, and successful as an executive. Minimum salary $3000. D-90.

MECHANICAL ENGINEER, age 34, desires to locate in Brooklyn or near New York City. Twelve years' experience in industrial plants, covering design, maintenance and construction work. Salary commensurate with ability. Only permanent position will be considered. D-91.

GENERAL MANAGER OR PRODUCTION SUPERINTENDENT. Member, American, age 46, with 23 years' technical training, practical shop experience and shop management manufacturing steam and gas engines, electric motors and generators, mining and transmission machinery, dairying machinery, pumps, shrapnel and high-explosive shells, time and graze fuses. Shop training covers production from design through shops to assembly, test and shipping. Technical covers building and plant extension, hydraulic-pneumatic, electric and steam power plants, machine-tool design. Office experience covers routing, costs, time study, wage systems, estimating and purchasing. Organization, systematizing, correct arrangement of machinery, proper routing of material, rapid, accurate production with unskilled labor by means of foolproof jigs and tools with coördination of departments has always shown increased output and reduction of costs. D-92.

MECHANICAL ENGINEER with 15 years' experience in the design of power plants, industrial plants, heating, ventilating, etc. Has had charge of men and shown executive ability. At present holds responsible position but has very little work to do. Willing to consider responsible and permanent position only. D-93.

YOUNG MECHANICAL ENGINEER. Technical man with 5 years' practical experience as designer and engineer desires change. Experienced on tools and equipment for manufacturing both large and small interchangeable parts. D-94.

PUBLICITY ENGINEER. Technical graduate who is over draft age and thoroughly experienced in advertising and cataloguing mechanical appliances desires permanent position with high-class manufacturing concern. American, good health and appearance clean record. D-95.

SUPERINTENDENT machanically trained and educated, thoroughly conversant with today's methods of production, and experienced in laying out the proper lines to follow in economical and interchangeable manufacture. Twenty years' successful practical experience in the manufacture of fine tools, reamers, dies, etc., light automatic machinery, hand screw machines, and cylindrical grinding machinery. Capable of taking entire charge of entire factory, but willing to accept position as assistant to high executive in large plant. Now employed as general superintendent. D-96.

MECHANICAL ENGINEER who has specialized on drop forgings desires to make a change—reasons on request. Age 32, married, American-born of American parents. Desires permanent position with reliable concern. Salary $2500 to $3000. D-97.

MECHANICAL ENGINEER. Technical graduate, age 25, married, desires position April 1. Has had one year of factory and shop experience and three years' intensive experience in the practical operation, maintenance and erection of Diesel oil engines, producer-gas engines and high-duty steam pumping engines. D-98.

FACTORY EXECUTIVE. Member, American, age 40, married. Technical college training and 18 years' successful experience with largest manufacturing concerns as chief draftsman, superintendent and manager in developing, organizing and producing. Six years in present position. Best of references. Responsibility of full authority. Salary $6000. D-99.

WORKS MANAGER OR GENERAL SUPERINTENDENT. Broad-gage, fully-trained executive, age 36, desires connection with large plant making any product from automobiles to clocks. Experienced in plant layout, best shop practice, management control methods, systems and man training: successful in all jobs through production, design and control divisions. Man whose vision is equal to possibilities of business and accustomed to make plans become facts. D-100.

GENERAL MANAGER OR GENERAL SUPERINTENDENT wants position on either Atlantic or Pacific Coast. Thoroughly versed in design and construction of marine engines and boilers and stationary engines. Varied practical and theoretical training and experience. Accustomed to responsible positions. Satisfactory reasons for desiring change from present position. D-101.

TURBINE DRAFTSMAN. Junior member, age 27, married, desires position with small, growing concern in engineering or sales department. College graduate with 6 years' turbine experience. At present employed as assistant to chief draftsman. Salary to start $150. D-102.

SKILLED OPERATING ENGINEER, experienced in design, construction, and operation of modern power plants, will consider a position to take full charge of a plant of 5000 kw. or larger. Can show results in the boiler room and get the best results from the equipment. At present mechanical engineer for a group of properties. D-103.

JUNIOR MEMBER, age 29, married, desires position as assistant professor of drawing and mechanical engineering. M. E. degree from a prominent eastern university. Some executive experience serving as director of department for one year. Location eastern college or university preferred. D-104.

ASSISTANT SUPERINTENDENT OR ASSISTANT ENGINEER. Associate member, age 35, with three years' experience as assistant engineer and engineer of tests on Diesel oil engines. Over six years mechanical engineer for large textile concern in charge of all mechanics, buildings, machinery and building construction and yard improvements. D-105.

EXECUTIVE OR ASSISTANT TO SUPERINTENDENT OR MANAGER. Member, American, age 50, married; practical mechanic, draftsman and designer. Thirty years' manufacturing experience, covering pattern, forge, iron and brass foundry, and machine shops; also 5 years' erecting experience throughout New England. Can handle correspondence, make estimates, figure costs, etc. Especially familiar with hydraulic work, comprising pump, tank and pipe problems. Well versed in plant upkeep, purchasing, etc. Location desired eastern New England. Salary $2500. D-106.

INDUSTRIAL AND PRODUCTION ENGINEER. M. E., age 31, married, with 12 years' active shop, field and office experience in the design, manufacture and production of industrial machinery and plants. Good organizer and tactful executive to introduce, develop or maintain bonus, cost and stock systems, standardization, scheduling, routing, and other production problems, to meet actual conditions. Good reasons for leaving present connection of five years, with large corporation in above capacity. Salary $3600. D-107.

SUPERINTENDENT, PRODUCTION MANAGER, EFFICIENCY ENGINEER, MASTER MECHANIC. High-grade executive with 22 years' practical and technical experience in manufacturing, covering every branch of the metal and wood manufacturing line, including the business end. Expert on equipment and system. Have had charge of plants employing up to 6000 men. At present employed as consulting and efficiency engineer. Thoroughly versed in gray-iron and brass foundry practice. Desires permanent position where efforts will be recognized. D-108.

MECHANICAL ENGINEER. Member, technical graduate, American, desires position as assistant engineer or chief draftsman. At present employed as designer, estimator and testing engineer. Sixteen years' experience, including testing, designing excavating machinery, tractors, derricks, hoisting engines, cargo winches, steering engines, anchor windlasses, and miscellaneous machinery, office engineering, machine-shop and steel-foundry practice. Location Middle or Far West preferred. D-109.

MECHANICAL ENGINEER. Junior member, Cornell graduate, M.E., age 27, American, married, classified in 4th class of Federal draft. At college, specialized in design of internal-combustion engines; since then employed as draftsman and assistant office executive, in which position duties consisted of testing steam power plants, adjusting complaints on coal, and handling correspondence. At present employed in the latter capacity. Minimum salary $2100 per year. Location preferred, New York. D-110.

EQUIPMENT ENGINEER. Graduate of English college of recognized standing, age 27, married. Experienced in the manufacture and inspection of interchangeable parts and design of equipment. Can take charge of drawing room and would like to get in touch with a firm concerning a permanent position. At present employed. D-111.

MECHANICAL-ELECTRICAL ENGINEER. Michigan graduate, age 32. Four years' experience in consulting engineering, designing, testing, estimating and writing reports on power plants and power equipment and four years' experience in selling electric and steam power service for central station. Available in two weeks. Salary $2500-$3000, depending on location. D-112.

EXECUTIVE MECHANICAL ENGINEER. Member, age 41, American, married. Twenty years' practical experience as designer, chief engineer, general manager, and consulting engineer. Thoroughly conversant with all details of shipbuilding—medium-sized steel and wooden steamers, machine and foundry business, manufacturing special machinery and tools, steam engines, boilers, hoisting machinery, dredging and excavating machinery, marine auxiliaries, and repairs to same. Desires change, preferably with new company on war contracts, ships, engines or special machinery. Permanent executive position considered, or temporary war business on a consulting basis. D-113.

MECHANICAL ENGINEER. Member, age 44, with 17 years' experience with steam railroads and 3½ years on valuation work, desires to make change. Technical graduate, now employed. Salary $4800 or better. D-114.

DESIGNING ENGINEER. Graduate mechanical engineer, 37 years old, with 14 years' varied engineering experience, principally on the design of power machinery and machinery location plans. At present employed but desires a permanent position. Replies desired only from those actually in need of a man for permanent position D-115.

ASSISTANT GENERAL SUPERINTENDENT OR WORKS MANAGER, OR GENERAL MANAGER OR ENGINEER OF SMALL PLANT. Young mechanical engineer who has successfully held similar responsible positions and served adequate time in shop and drawing office. Specialized on production work, having full charge of designing and building internal-combustion engines and automatic machinery. Capable executive, thoroughly practical and aggressive, at present employed as chief draftsman of a large concern. 33 years of age, married, 18 years' total experience. D-116.

EXECUTIVE OR MANAGING ENGINEER, Member, age 43, married, 20 years' engineering experience. Good organizer and executive, experienced in design of locomotive engines, cars and heavy machinery, as well as in the direction of shop, drafting-room and office forces. Familiar with estimating and sales engineering. Highest-class references. Salary $5000 or equivalent on bonus or commission plan. Eastern location preferred. D-117.

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and Selected Titles of Engineering Articles

Research Information Committee Formed

The following statement is authorized by the Council of National Defense:

1 By joint action the Secretaries of War and Navy, with the approval of the Council of National Defense, have authorized and approved the organization, through the National Research Council, of a Research Information Committee in Washington with branch committees in Paris and London, which are intended to work in close coöperation with the officers of the Military and Naval Intelligence, and whose function shall be the securing, classifying, and disseminating of scientific, technical and industrial research information especially relating to war problems, and the interchange of such information between the allies in Europe and the United States.

2 The Washington committee consists of—

a A civilian member, representing the National Research Council; Dr. S. W. Stratton, Mem.Am.Soc.M.E., Chairman.

b The Chief Military Intelligence Section.

c The Director of Naval Intelligence.

3 The initial organization of the committee in London is—

a The scientific attaché representing the Research Information Committee: Dr. H. A. Bumstead, attache.

b The military attaché, or an officer deputed to act for him.

c The naval attaché, or an officer deputed to act for him.

4 The initial organization of the committee in Paris is—

a The scientific attaché representing the Research Information Committee: Dr. W. F. Durand, Mem.Am.Soc.M.E., attaché.

b The military attaché, or an officer deputed to act for him.

c The naval attaché, or an officer deputed to act for him.

The headquarters of the Research Information Committee in Washington is in the offices of the National Research Council, 1023 Sixteenth Street; the branch committees are located at the American Embassies in London and Paris. (*Official Bulletin*, March 8, 1918, p. 8.)

New U. S. Bullets Deadly to Planes

Special bullets, designed for aerial work, that combine armor-piercing and incendiary qualities, and also armor-piercing and tracing, have been developed by the War Department to a point fully equal to or surpassing those used abroad.

Armored-airplane construction, adopted since the European war started, brought the necessity for a new type of bullets. The necessary type was developed for use against the gasoline tank of enemy machines, the most vulnerable spot, and the tracer bullets enable the aviator to judge the result of his fire just as well at night as in daylight. The size of the bullet has been kept to 0.30 caliber, and types have been perfected that gave splendid results in tests.

"With the progress of the war," says the War Department statement, "the more vital parts of the airplane were protected with light armor, so that it became necessary to introduce the armor-piercing bullet.

"As the gasoline tanks were particularly susceptible to explosion, it was necessary to procure a bullet containing an inflammable substance ignited upon discharge, which would carry the spark of flame into the tank when piercing it.

"As the target was within range for only brief moments at a time and as there was no means of determining the fire effect, as on land, a tracer bullet containing a bright-burning composition was introduced. The composition is set on fire upon discharge and the bullet flies through the air as a bright spark, plainly visible to the machine-gun operator.

"At the outbreak of the war further information was promptly gathered from the Allies and this subject was studied by those responsible for this work in the United States. Of course, on account of the difficulties of the problem, none of the special bullets possessed by any country is entirely satisfactory, or what might be termed 'perfect' in operation.

"The bullets developed by the United States Ordnance Department have been tested on land and from airplanes to see if there is any difference in their performance when fired from a quickly-moving airplane in the upper atmosphere and when fired on land. These tests indicate that the United States has developed a class of special cartridges with a performance fully equal to or surpassing that attained abroad." (*Philadelphia Public Ledger*, March 4, 1918, p. 6.)

The Liberty Motor

Several official statements have been made to the effect that the Liberty motor is in production. In fact, it has been stated that the various companies now engaged in its production, such as the Packard Company, the Lincoln Motors Company, etc., have or soon will reach a daily production of 250 engines a day.

The aeroplanes shipped to France have been equipped with the Liberty motor. Likewise, in the early part of March, the first fighting seaplanes built in America have been accepted for service. These seaplanes, which are said to be substantially similar in construction to the British flying boats, are each equipped with two Liberty motors giving a useful output of about 700 hp.

In the final tests and refinements of the motor the Aircraft Board was assisted by a supervising committee consisting of D. McCall White, Mem.Am.Soc.M.E., and Henry M. Crane, Mem.Am.Soc.M.E.

A bit of light has been thrown on the history of the Liberty motor by Emden S. Hare, president of the Packard Motor Company of New York, in an address at the dinner of the Sphinx Club in New York. According to this statement the Liberty motor was the outcome of three years' work on the part of the Packard engineers. The company offered this engine to the Government. At the time, the Aircraft Board felt that it would be best in the furtherance of their war plans not to put this motor out under the name of the Packard Company, and the company patriotically sacrificed its private interests in the motor and consented to let its work be merged under the name of Liberty motor.

Conjoint Board of British Scientific Societies

A report on the work of the Board for the first year of its existence, 1916-1917, has been issued.

On March 22, 1916, at the instance of the Council of the Royal Society, a conference was held with representatives of the leading scientific societies at which it was decided to organize such a conjoint board.

The Board was eventually organized for the purpose of promoting the coöperation of those interested in pure and applied science; supplying a means by which the scientific opinion of the country may, on matters relating to science, industry and education, find effective expression; taking such action as may be necessary to promote the application of science to industries and to the service of the nation; in discussing scientific questions in which international coöperation seems advisable.

The Board consists both of purely scientific societies, of engineering organizations, such as the Institutions of Civil, Electrical, Mechanical, and Mining Engineers, semi-engineering organizations like the Geological Society, and organizations of the type of the Physical and Zoological Societies. Even the Biochemical Society and the Psychological Society have found a place in the wide scheme of organization of the Conjoint Board, which thus represents the scientific and engineering mind of the country in the broadest and best sense of this term.

As regards financing, the Royal Society extended to the Conjoint Board the hospitality of its rooms and guaranteed the expenses of the Board to the sum of £200 during the first year. In addition to this, the constituent societies each contributed sums varying from £10 to £50. A number of important sub-committees were appointed and a majority have presented final or interim reports.

Thus the Sub-Committee on the Application of Science to Agriculture has, among other things, initiated a careful census in districts where there are various classes of agriculture, the object of the census being to ascertain the amount of produce sent out from, and the raw materials conveyed to, these districts; the time when such transport is effected, as well as the time occupied in seasonal operations on the lands. It is hoped from this detailed information to obtain valuable data on which to build practical estimates of the power required and cost of operation and compare the relative advantages and costs of steam engines, internal-combustion engines and electrically operated machinery.

The question of application of electrical machinery to agriculture has received particular consideration, the Sub-Committee emphatically believing in its great future. In fact, the Sub-Committee believes that electrical power can be distributed to farms at prices which would pay the farmer. Electrically propelled plows and other agricultural machinery would be simpler in construction and easier to handle and inspect than oil-driven machinery. Further, electricity may be used for intensive cultivation, as is indicated by some recent experiments.

Another sub-committee is instrumental in drawing attention to the need of national instruction in technical optics.

A Watching Sub-Committee on Education has been instituted in order to keep the Board of Scientific Societies informed on any matters in education which might arise from time to time and might have a bearing on the relation of education in science to national needs and to the special requirements of scientific industries. Its chief attention has been occupied so far with an attempt to secure unity of purpose between those anxious to insure that natural science shall, in the future, form a more important part in early education than has been the case in the past and those who have had their interests more particularly concerned with the development of literary and linguistic studies.

A Metric Sub-Committee was organized in 1917 and is now engaged in the preparation of a report. Other sub-committees are apparently vigorously at work.

Boston Society of Civil Engineers

FOUNDATIONS OF THE NEW BUILDINGS OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASS. A paper with this title was presented at the December meeting by Charles T. Main, President, Am.Soc.M.E., and H. E. Sawtell. The purpose of the paper was to describe the geological conditions found at the site of the Massachusetts Institute of Technology and the methods used in determining these conditions, the selection of the type of foundations and the pile tests, load tests and designs of portions of the foundations. Because of lack of space only the latter part of this interesting paper can be reported here.

Two considerations led to the selection of wood piling in preference to concrete piles. First, it was found that wood piling would be considerably less expensive than concrete piles, because of the fact that the permanent water level was high and hence it was unnecessary to place any concrete in addition to that required for the foundations to meet the heads of the wood piling. Further, large piles do not prove economical where flexibility is required for light as well as heavy loads. In this case it was decided that heavy concentrated loads should be avoided, which in itself precluded the use of concrete piles.

In order to determine the kind and length of wood piles to use in different parts of the site, a sufficient number of tests became necessary, a rather difficult task owing to the great variety of soil conditions present.

The complete data of these tests, especially valuable because of the wide ground covered, are given in a series of tables. Some of the piles (spruce) were driven into the "glacial gravel," in this instance a well-compacted and deep bed of material, commonly known as coarse sand and gravel, to various depths, and upon being pulled were all found to be broomed or both broomed and broken.

This showed that spruce piles could not be driven with safety into the harder portions of the glacial deposit, and the use of spruce was confined to those places where friction was largely depended upon to give the bearing value and very little dependence placed on point bearing. Also it was decided not to use spruce piles when sudden changes in the hardness of the soil were found or expected.

On the other hand, tests proved that first-class oak piles could be driven without injury into well-compacted coarse sand or fine to a resistance giving a value of 18 tons or more. Hence, oak piles were used when the driving was hard and when the supporting value of the piles was to be gained largely from point bearing and relatively small embedments in the hard stratum.

The varying conditions of the ground made it necessary to take particular care to design the pile foundations on the basis of as nearly uniform settlements as possible. Such

uniformity is highly desirable in order to prevent overstressing the more or less continuous concrete floor of beams and slabs used in the superstructure of the buildings.

It was considered necessary that the piling have a safety factor of not less than 2.5 of tonnage, based on the limit of ¼-in. settlement.

An effort was made to keep the piles in the glacial deposit, even where it thinned up, as it was desirable to use this stratum as a medium for spreading the loads over the clay under it.

It was endeavored to have a minimum of at least 3 ft. of gravel under the points, even where it became thin, in order to make the spreading of the load somewhat effective.

Regarding the safe working values, the tests have shown that the piles driven into sand and dependent upon friction for support could be used at their formula value (the so-called *Engineering News* formula is referred to), but not much higher than the limits of settlements and safety factors assumed. On the other hand, piles embedded in the clay found at this site showed an ability to carry test loads in excess of the formula value when using drop hammers.

A feature in the design of these foundations which was given some consideration was the matter of vibration due to external and internal forces. It was expected that the greatest vibration would come to the structure from external sources, such as freight trains, electric cars, etc., conveyed to the buildings by means of the comparatively hard top film which lies over the stratum of mud, silt and peat.

As a matter of fact, nearly the entire site of the new buildings has a stratum of mud, silt and fill above the glacial deposit and clay. The buildings have a foundation of piles, which have their entire length above the part embedded in sand and gravel or clay, pass through a material affording very little support, and it is known that structures supported in this way not only readily send out vibrations but are strongly affected by vibrations from other sources, if situated above the same strata.

One method of partially resisting such a tendency is to drive the piles well into the supporting stratum rather than resting them on the surface or with a foot or two of penetration, but as a fair embedment was necessary anyway to get the bearing values desired, the question of stiffness was solved automatically.

Working rules for governing the driving of piles are given. (*Journal of the Boston Society of Civil Engineers*, vol. 5, no. 1, January 19, 1918, pp. 1-38, 16 figs., *deA*)

U. S. BUREAU OF STANDARDS

Central Hot-Water Heating. The Bureau has made studies of central water-heating systems in fifteen cities in the Middle West, for the purpose of formulating technical standards of service for such central heating systems. The work is carried on in close coöperation with the engineers of the Indiana Public Service Commission and with the Educational Committee of the National District Heating Association. The results will be embodied in a circular entitled Standards of Service for Central Heating Plants, similar to the circulars already published by the Bureau of Standards on Standards of Gas Service and Standards for Electric Service.

Gas Engineering. The readjustment of gas quality and rates is an acute question in several states. This situation enabled the Bureau to render prompt service by the application of the experimental results obtained by the Bureau last year. The appointments of a number of additional gas engineers are now pending. These will enable the Bureau to take up pressing problems in gas engineering.

Military Research. Confidential investigations are in progress on gun-firing measurements, sound ranging, battleship telephony, lighting, optical instruments, signaling, aeroplane construction, thrust and torque, use of concrete for ships, and many other similar subjects of importance in the war. The nature of these problems is, of course, confidential, so that the results will not be known until the close of the war or until published by the Military Departments. A new laboratory, somewhat larger than any of the existing bureau laboratories, is to be constructed in the immediate future.

Electrolysis Survey. The Bureau of Standards is preparing the report on a survey of the city of New Orleans, in which the electrolysis conditions were very carefully investigated. The request for this survey was made jointly by the city of New Orleans and the utilities companies concerned. The report will give the recommendations to the city and to the utilities for ameliorating the unfavorable conditions found.

Inspecting and Testing of Electric Lamps. The Bureau's work during the past six months has been nearly three times the amount for the previous year. The great demand has led some factories to deliver lamps of lower quality than heretofore, but this has been corrected in the recent deliveries.

Infra-Red Spectroscopy. Hundreds of new lines have been discovered by the Bureau in the infra-red spectroscopy of iron, cobalt and nickel. The investigations have been completed as far as the apparatus and photographic methods permit. Many of the newly discovered lines of wave lengths are greater than 10,000 angstrom units. The reports have been prepared for publication.

Weathering of Optical Glass. The effects of the collection of water vapor and resistance to the weathering action by different types of optical glass are being investigated by the Bureau. It is expected that these investigations will develop means of producing a better quality of optical glass. Large numbers of optical parts and optical apparatus are being tested for the military departments and special problems are under investigation, especially those which have arisen from the use of American-made optical glasses.

Engineering Instruments. Typical examples of calibration work in this division included during the past month water-current meters, pressure and vacuum gages, relief valves, and a fatigue test of a pressure gage in an investigation using 30,000 lb. per sq. in.; pressure tests of metallic tubing and copper spheres, fire extinguishers, and similar lines of engineering tests.

Tensiometer. The Bureau has devised an instrument and constructed it for the purpose of measuring the loads on cables. The test was successfully completed and the instrument calibrated. Large numbers of woods, metals and structural parts have been tested on the large Emory testing machine for military purposes.

Building-Stone Investigation. The automatic freezing and thawing apparatus which has been in continuous operation during the past month has subjected to alternating freezing and thawing a number of sandstones and limestones, as high as seven hundred and fifty alternations in some cases. Most of the samples showed visible signs of disintegration. The aim is to ascertain the effect of frost action on building stones,

concrete, etc., and establish the relative durability of the various types. The specimens are shifted automatically between a cold chamber and a warm chamber at suitable intervals to permit freezing and thawing. In this manner the freezing equivalent to years of exposure may be obtained in a comparatively short time.

Effect of Calcium Chloride on the Strength of Concrete. This investigation was undertaken to determine the effect of using solutions containing small amounts of calcium chloride as the gaging water in mixing concrete on the rate of increase in strength of concrete. Results to date, including tests of concrete a year old, show that an aqueous solution of from 4 to 6 per cent of calcium chloride used as the gaging water of portland-cement concrete will increase the strength at two or three days from 50 to 100 per cent over concrete of the same proportions and age gaged with plain water. No detrimental effect has as yet been noted on the concrete in which the calcium chloride has been incorporated.

Tests of Leather. An investigation of the wearing qualities of the different grades of leather in actual service and as tested by the Bureau of Standards leather-testing machine is now being carried out on a much larger scale than before. The District of Columbia postmen have been furnished with shoes with sole-leather and fiber-composition soles. One is placed on one foot, the other on the other. The test is being extended to include soldiers at Camp Meade. A careful record is kept of their behavior, the nature of wear, weather conditions, etc. A representative of the Leather Section of the Bureau makes weekly inspection trips to Camp Meade.

Optical Glass. The Bureau's work on optical glass is progressing satisfactorily. During the month sixteen melts were made, ten in pots manufactured at the Bureau and two in porcelain pots. The glasses made included a dense flint of fine color, the usual medium flints, light crown, boro-silicate and light barium crown glasses. The tests of porcelain and semi-porcelain glass pots are being continued. The large porcelain pots have proven to be very successful.

Tile Investigation. Nine full-size hollow-tile walls were tested in the 10,000,000-lb. compression machine. The walls varied from 6 to 12 in. in thickness, were each 4 ft. wide and 12 ft. high, and were laid in cement mortar tempered with lime hydrate. The walls were laid up with the flues horizontal instead of vertical, which distinguishes this series from the previous one. These walls showed only about 30 to 50 per cent of the strengths when tested vertically and with the vertical flue walls carrying from 300,000 to 600,000 lb. load. The tendency to local fracture in the outer webs of the tile is the rule when the flues are laid horizontal, although there is a better bonding. A great deal of interest has been shown by building code experts and tile manufacturers in the tests. About thirty walls have been tested thus far and the tests are being continued with the coöperation of manufacturers.

This Month's Abstracts

In the next issue of THE JOURNAL will appear one or more abstracts from *La Technique Moderne.* This important French publication was discontinued soon after the beginning of the war, but is starting again. This is a welcome sign, showing that not only is the technical life of France getting back on its feet, but also that the general situation in the country cannot be very bad if an expensive technical journal finds enough subscribers to keep it going.

In the section Aeronautics, Lieut.-Col. Crocco of the Italian Arm presents an interesting discussion on the resistance of air when the matter is considered not as a perfect fluid, but, on the contrary, as a dissipater of energy. Certain aerodynamic phenomena are then considered from the point of view of valuation of momentum communicated to the air, which was originally immobile.

In the section Engineering Materials are reported the cardinal features of an investigation on the strength of sewer pipe.

In the same section will be found a discussion of the properties of wire rope for aircraft of particular interest in that it brings out how the method of manufacture, especially the speed in stranding and closing the rope, affects its ultimate physical properties.

A paper read before the Kentucky Ice Manufacturers' Association by W. D. Stuckenberg and J. F. Kohout presents some interesting features in connection with storage and weathering of coal. A point of particular interest brought out is the influence of outside sources of heat on the spontaneous ignitability of coal, including the influence of sun heat.

In the section Fuel is also described a new method of burning powdered coal, the distinctive feature of which is that the arrangement is such that the powdered fuel, thoroughly dried, is conveyed practically as if it were a fluid. This permits the use of a comparatively small size of piping of long length and at any necessary tilt or angle. An interesting system of regulation of the supply of coal is provided.

From the *Journal of the Society of Chemical Industry* is taken a brief report of an investigation on the melting points of coal ash. In the original paper a table is given of melting points of a number of ashes.

In *Power*, Sanford A. Moss, Mem.Am.Soc.M.E., describes a method of measuring high pressures of gases with dead weight as used at the Lynn Works of the General Electric Company. The dead-weight pressure gage is said to be more precise than the Bourdon gage, while quite simple in operation and calibration.

The description of a new hydrometer is indirectly taken from a German paper.

In the section Mechanics a lecture by Sir James Dewar before the Royal Institution is abstracted, giving interesting details of his recent studies of liquid films.

In a paper before the Society of Automotive Engineers, Arthur B. Modine discusses the principles of tractor-engine cooling, and, among other things, emphasizes the fact that the rate of cooling effected in the radiator is a function not only of the rate of flow of the air through the radiator, but also of the rate of flow of water.

An extensive discussion of electric boiler heating for steam locomotives is abstracted from a German publication.

Through the *Railway Age* is abstracted an extensive report on the study of railway track under load carried out by a special joint committee of the American Society of Civil Engineers and the American Railway Engineering Association.

In the section Steam Engineering, particular attention is called to two abstracts; the first describing the 50,000-kva. Connors Creek turbines of the Detroit Edison Company, and the second discussing steam raising by electricity with heat storage, this latter being the data of an experimental investigation carried out in 1916 in Switzerland.

Several interesting abstracts appear in the section Thermodynamics, notably one of an article by H. P. Gillette, Mem.Am. Soc.M.E., in which the writer examines the gas-film theory in its relation to heat conduction.

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

STATIC THRUST AND BRAKE HORSEPOWER OF AIR PROPELLERS
CARDINAL PRINCIPLES OF AERODYNAMICS
AIR AS A DISSIPATER OF ENERGY
BLAST-FURNACE PREHEATER
SEWER-PIPE STRENGTH
WIRE ROPE FOR AIRCRAFT
STORAGE AND WEATHERING OF COAL
POWDERED COAL, NEW METHOD OF BURNING
MELTING POINTS OF COAL ASH
MOTOR FUEL, TESTING AND STANDARDIZATION
ANALYTICAL DETERMINATION OF DUTY OF WATER
LUBRICATION OF BALL BEARINGS
DEAD-WEIGHT PRESSURE GAGE FOR MEASURING HIGH PRESSURES
PROPORTIONING OF UNSYMMETRICAL CONCRETE ARCHES
LIQUID FILMS
ENGINE COOLING
ANTI-AIRCRAFT FIRING
ELECTRIC BOILER HEATING FOR STEAM LOCOMOTIVE
RAILWAY TRACK UNDER LOAD
MODULUS OF ELASTICITY OF RAIL SUPPORT
WHEEL CONTACTS OF RAIL HEADS
COUNTER-PRESSURE BRAKE FOR RAILROADS
DYNAMIC AUGMENT ON LOCOMOTIVES
PURITY OF AMMONIA AND REFRIGERATION
50,000 SQ.-FT. SURFACE CONDENSER
MERCURY-EXPANSION JOINT FOR SURFACE CONDENSER
CONNORS CREEK STEAM TURBINES
STEAM RAISING BY ELECTRICITY WITH HEAT STORAGE
GAS-FILM THEORY AND HEAT CONDUCTION
THERMODYNAMICS OF THE THROTTLE VALVE
NERNST THEORY AND THERMAL EXPANSION OF SOLID BODIES
NERNST THEORY OF HEAT CHARTS

For Articles on Subjects Relating to the War, see Aeronautics, Engineering Materials, Machine Tools, Munitions, Varia

Aeronautics

APPROXIMATING THE STATIC THRUST AND BRAKE HORSE POWER OF AIR PROPELLERS, W. Bernard Murphy. The static thrust and b.hp. of air propellers are here discussed on the basis of the formulæ for air screws developed by W. R. Turnbull and published by him in the *Aeronautical Journal* for January 1912. The article is illustrated by two charts, one giving the values of the coefficient Q in the Turnbull formula and the other the coefficient of U for flat-face sector screws. The first chart is for a two-blade and the second chart for a two- and four-blade propeller. (*Aviation and Aeronautical Engineering*, vol. 4, no. 2, February 15, 1918, pp. 89-90.)

THE INFLUENCES OF STANDARDIZATION IN WAR AERONAUTICS. The influences of standardization are discussed from two points of view: the one as they affect production and the other as they affect the developments of types. Standardization is defended as a means of increasing the speed production and attacked as possibly retarding the development of the best types. (*Journal of the Aeronautical Society of America*, vol. 2, nos. 20-24, July-December 1917, pp. 3-24.)

THE TWO CARDINAL PRINCIPLES OF AERODYNAMICS, Lieut.-Colonel Crocco. The article discusses the resistance of the air from the point of view of considering the air not as a perfect fluid, but, on the contrary, as a dissipater of energy. Theoretical results of considerable importance are obtained in this way, even though the practical dependence of propelling power on the way in which the disturbed air circulates and loses its energy is limited to the cases in which the size of the closed spaces where the experiment is made is out of proportion to the sizes of the generated fluid jets. The writer introduces in aerodynamic phenomena a principle for the valuation of generative forces, which is that of momentum communicated to the air which was originally immobile. (*Aeronautics*, vol. 14, no. 224 (new series), January 30, 1918, pp. 104-110, 10 figs.)

MECHANICS OF AEROPLANES AT HIGH ALTITUDES, Herbert Chatley. *Aeronautics*, vol. 14, no. 224 (new series), January 30, 1918, pp. 114-116.

DOPE POISONING. *Automotive Industries*, vol. 38, no. 10, March 7, 1918, pp. 493-495.

ON THE STATICS OF SCREWS, Rodolphe Verduzio. *Aeronautics*, vol. 14, no. 225 (new series), February 6, 1918, pp. 128-129.

Air Engineering

BLAST-FURNACE PREHEATER. Description of new blast-furnace preheater invented by E. E. Marshall. The principle of this device is to take air coming from the blast engines and pass it through a preheating device prior to its admission into standard firebrick stoves. It is claimed that in this way a more even temperature is secured.

The construction of the preheater is the same as that of the old iron-pipe stoves used in blast-furnace practice prior to the invention of the modern firebrick stove. It consists of a combustion chamber, a pipe chamber and a draft-stack chamber. The gas and blast flow in parallel. This is done to keep the first row of pipes cool by the incoming blast, and thus protect them from warping and burning out. The blast is heated under predetermined temperature in the preheater up to 900 deg. fahr. The action of the preheater on the stoves is as follows:

The firebrick stoves coming off of gas are put on the furnace. The preheated blast is admitted through the cold-blast valve on the stoves. As the preheated blast has attained a rather high degree of heat in the preheater, the heat surface of the stoves is not cooled off as fast as it could be if cold blasts direct from the blast engines were admitted to the same heat surface. Hence the reduction in stove temperature during the period that the stoves are on the furnace is not large, and the blast gets a more uniform degree of heat. It is claimed that because of this small variation in the blast temperature the amount of fuel is reduced. It is also stated that with the preheater connection on the stoves, the checkers in the stoves do not accumulate dirt as they do without this adjustment.

It is stated that such preheaters have been installed at Newport, Pa., and at the Lochiel furnace at Harrisburg, Pa., with satisfactory results. (*Iron Trade Review*, vol. 62, no. 9, February 28, 1918, pp. 541-542, 1 fig., *d*)

FIRST REPORT TO THE COUNCIL OF THE NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS ON CERTAIN METHODS OF PRODUCING HIGH VACUUM, Edwin L. Orde, C. W Cairns and J. Morrow. *Transactions of the North-East Coast Institution of Engineers and Shipbuilders*, vol. 34, pt. 2 February 1918, pp. 83-132, illustrated.

VENTILATEURS SULZER. *Bulletin Technique de la Suisse Romande*, 44 annee, no. 2, January 26, 1918, and no. 3, February 9, 1918. Description of Sulzer blowers made in Switzerland (to be continued).

Blast Furnaces (See Air Engineering)

Engineering Materials

THE STRENGTH OF SEWER PIPE. An abstract of Bulletin No. 47 of the Engineering Experiment Station of the Iowa State College of Agriculture on the supporting strength of sewer pipe in ditches and methods of testing sewer pipe in laboratories to determine their ordinary supporting strength.

It has been proved that the pipe in the ditch is so much more rigid than the ditch filling at each side of the pipe, that even with careful tamping the pipe carries practically all of the vertical load at the level of the top of the pipe caused by or transmitted through the ditch filling.

The width of the ditch at the elevation of the end of the top 90-deg. quadrant is the width factor that affects the load on the pipe. The ditch may widen indefinitely above this level without increasing the load on the pipe appreciably.

The following formula has been deduced for the loads on pipes in ditches where the trench is hollowed to conform to the bottom quadrant of the circumference of the pipe:

$$W = Cwb^2$$

where W = load on pipe in ditch, lb. per lin. ft.
C = coefficient (see Table I in original article).
w = weight of ditch-filling material, lb. per cu. ft.
b = breadth of ditch a little below the top of pipe, ft.

In computing the ordinary supporting strength of pipe per unit of length, the net inside length of the pipe from the bottom of the hub socket to the extremity of the spigot end should be used as a divisor. For calculating the modulus of rupture of sewer pipe from the ordinary supporting length, the formulæ already adopted for drain tile by the American Society for Testing Materials should be used, as follows:

$$M = 0.20rW/12, \text{ and } F = 6M/t^2$$

where M = maximum bending moment in the pipe wall of the barrel of the pipe, lb-in. per inch of length.
r = radius of the middle line of the pipe wall of the barrel of the pipe, in.
W = ordinary supporting strength of the pipe, calculated as described in the preceding paragraphs, lb. per lin. ft. of pipe.
F = modulus of rupture of the pipe, lb. per sq. in.
t = average thickness of the pipe wall of the barrel of the pipe in inches at either the top or the bottom, the lesser value being used.

In computing M, for "sand" bearings add 5/8 of the weight of the pipe per linear foot to W, provided such addition exceeds 5 per cent of W. For "two-point" or "three-point" bearings add 3/4 of the weight of the pipe. (*Western Engineering*, vol. 9, no. 2, February 1918, pp. 57-59, 2 tables.)

SEVEN-YEAR TESTS SHOWING THE EFFECT OF AGE AND CURING CONDITIONS ON THE STRENGTH OF CONCRETE, M. O. Withey. In this investigation it has been found that the more pronounced variations in the strengths of the neat-cement test pieces are due largely to the embrittling of the specimens with age. Furthermore, neat-cement specimens stored in air are probably much more weakened due to surface defects than are mortar or concrete test pieces stored under similar conditions. The major portion of the strength of concrete appears to be secured at an age of six months to one year. At the age of seven years water-cured concrete is slightly stronger than concrete cured out of doors and considerably stronger than concrete cured in the cellar.

It has been found that the effect of differences in the humidity of the storage condition is much more pronounced at the age of seven years than it is at the age of six months, which emphasizes the importance of maintaining the water contained in the concrete at all ages if maximum strength is to be secured. (*The Wisconsin Engineer*, vol. 22, no. 5, February 1918, pp. 183-188, 2 figs., 1 table.)

ANNEALING OF CARBON STEELS, R. B. Fehr. *The Pennsylvania State College Bulletin*, vol. 11, no. 11, October 1, 1917, pp. 84-101, 7 figs., 6 tables.

LA DURETÉ DES ALLIAGES MÉTALLIQUES INDUSTRIELS, P. Ludwik. *La Technique Moderne*, tome 10, no. 1, January 1918, pp. 30-33, 5 figs., 5 tables. Deals with the hardness of industrial metal alloys.

MANUFACTURE OF ELECTRIC TOOL STEEL, E. A. Suverkrop. *American Machinist*, vol. 48, no. 9, February 28, 1918, pp. 351-358, 16 figs.

THE MANUFACTURE OF STEEL SHEETS, Clement F. Poppleton. *The Iron Age*, vol. 101, no. 11, March 14, 1918, pp. 676-679, illustrated (to be continued).

NOTES ON PREPARED PAINTS FOR METAL SURFACES. *Transactions of the Institute of Marine Engineers*, vol. 29, session 1917-1918, January 1918, pp. 339-345.

OCCLUDED GASES IN FERROUS ALLOYS, Gellert Alleman and Chas. J. Darlington. *Journal of The Franklin Institute*, vol. 185, no. 2, February 1918, pp. 161-198, 4 figs., 5 tables (to be continued).

PRINCIPLES OF THE GENERATION AND APPLICATION OF HEAT IN STEEL TREATING, A. F. MacFarland. *Proceedings of the Steel Treating Research Society*, vol. 1, no. 6, January 1918, pp. 9-15, 8 figs.

WIRE ROPE FOR AIRCRAFT. Discussion of the properties of wire rope for aircraft and certain special methods resorted to in order to give it the desired properties.

Wire rope is frequently the weakest link in otherwise strong engineering structures. It is claimed that elasticity is fully as important as tensile strength, and a tensile test alone is not sufficient for judging the wire. There is a possibility that in the future a simple form of streamline fairing will be developed, which will eliminate the so-called vibrant strains. Fairing reduces not only the vibration in the wire, but also the head resistance. In fact, it is claimed that a small wire vibrating rapidly offers as much head resistance as a flat surface, the width of which is equal to the amplitude of the vibration.

All rope specifications should provide for not only torsion, bending and tensile tests of the individual wire after drawing, but also for the material in rod form before drawing, as good wire can only be made from material of proper quality. Further, specifications of wire rope must also specify the elongation.

Hardness may be intensified by very high machine speed in stranding and closing the rope. If the elastic limit is not exceeded in the drawing operation no hardness results, but if the drawing subjects the material to stresses beyond the elastic limit, a certain amount of permanent set is produced and hardness is the result.

Hardness can be kept within reasonable limits in three ways: viz., first, by giving careful heat treatment during manufacture; second, by carefully drawing down the wire by quarter to half sizes; and third, by using moderate speed for stranding and closing the rope. A certain amount of hardness is desirable because a given hard-drawn steel wire will support

a heavier load than untreated steel, but increased tenacity is obtained at the expense of elasticity and may be carried to the point where the material becomes dangerously brittle. Fig. 1 shows how hardening the material raises its tensile strength and reduces its plasticity. The relation between Brinell hardness numbers and the tensile strength of drawn steel is expressed by the following equation:

Tensile strength, tons per sq. in. = 0.213 × Brinell number + 5.

Certain tests of wire rope in rod form and finished form are recommended. (*Aeronautical Engineering*, January 9, 1918, abstracted through *Automotive Industries*, vol. 38, no. 7, February 14, 1918, pp. 366-367, 3 figs., *p*)

Fuel and Firing

Storage and Weathering of Coal, W. D. Stuckenberg and J. F. Kohout. The question of storage of coal becomes of particular importance at the present time, when it may be possible that large consumers will have to accept their coal in equal monthly shipments, or receive a large share of it during the summer months, so as to relieve possible future railroad congestion.

Broadly speaking, the larger sizes of coal from about No. 3 nut on up through the various sizes of nut, egg and lump store without giving any trouble. Anthracite and semi-bituminous coals store well in any size. Black lignite or sub-bituminous coal from the West is hardly suitable for storage.

Difficult to store are the finer sizes of coal, which are used principally for power purposes; these are generally high in moisture and iron pyrites, and also, because of their smaller sizes, expose a great number of small surfaces to the air. These several factors all tend to initiate oxidation and to speed it along once it has started. Eastern coals are purer and lower in moisture and pyrite than western coals.

The speakers discussed in detail the conditions producing oxidation and rise of the temperature of the coal pile. In this connection they claim that the effect of external sources of heat is of extreme importance. In fact, without the aid of heat from some external source, the initial stages of oxidation either would not appear or their rate would be extremely slow. These sources of heat may be steam pipes in the ground or near the pile, or heat from boilers, especially in the case of bunkers on vessels. When coal is unloaded by dumping on the ground from a car or a high trestle, and then is piled up to almost the level of the car floor, as is frequently done in coal yards, the heat of impact and of pressure constitutes a positive danger to the coal.

Absorption of heat from the sun will also raise the temperature of the coal to a surprising degree. In the case of a certain shipment from a plant in Indiana, the coal carried a rather large amount of moisture and pyrite, but was taken out of the ground only about ten days before delivery. When received it was so warm that the hand could not be kept in contact with it for more than a few seconds. The reason for this was discovered to be the fact that it was shipped in steel cars, which stood on sidetracks exposed to the direct rays of the sun for about two days. If this coal had been placed in storage in the condition in which it was received, it would certainly have fired spontaneously in a short time. (Paper read before the Kentucky Ice Manufacturers' Association, abstracted through *Power*, vol. 47, no. 7, February 12, 1918, pp. 234-235, *p*)

A New Method of Burning Powdered Coal. Description of a fuel system in which the fuel is delivered from the pulverizing plant to the point of combustion by means of air pressure in distinction from systems in which continuous helical-screw conveyors are used, or systems in which the coal is carried by high-velocity air with the coal dust in suspension.

This new system has been applied to the plant of Dilworth, Porter & Co., Inc., Pittsburgh, Pa. The plant is noteworthy for the distances which the powdered fuel has to be carried, for the large size of the furnace, and for the type of feed control. It is of interest to note that the present equipment has replaced natural gas and that it has been operating with complete success throughout the recent severely cold weather.

The present scheme of conveying coal is based on the fact that powdered fuel when thoroughly dry acts as a fluid and thus allows for using piping of long length at any necessary tilt or angle. The powdered coal collected in tanks at the pulverizing station is subjected to air pressure in the upper part of the tanks and forced as needed from the bottom of the tank through the coal-delivery or transport pipes. Coal has thus been delivered for a length of 1500 ft., at a speed depending in part upon the air pressure. For example, 4 tons have been actually carried through a 550-ft. line in 5 min. with air at 40 lb. gage pressure. The coal is pulverized to pass 95 per cent through a 100-mesh sieve and 85 per cent through a 200-mesh sieve.

To introduce the powdered fuel into the air-transport system proper two blowing tanks are provided, each of a capacity of 5 tons per charge. Compressed air is supplied by a two-stage motor-driven air compressor fitted with feather valves which delivers into air receivers from which the air is admitted to the blowing tanks. An aftercooler is provided to remove moisture from the air as it leaves the compressor, as well as cool the air as it is being stored. In the head of the blowing tank there is a valve operated from the floor and controlling the flow of coal into each tank as well as preventing the escape of air when closed.

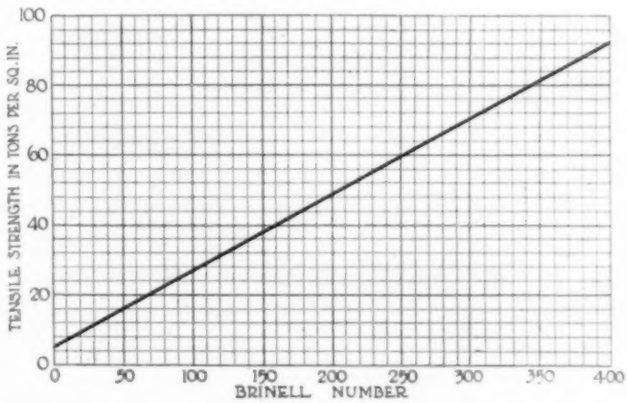


Fig. 1 Curve Showing Tensile Strength as a Function of Brinell Hardness

The powdered coal is directed into bins at the furnace when required by means of special switching valves operated from the floor by the hopper conveyor. The hoppers vary from 1 to 8 tons in capacity according to the furnace consumption.

Fig. 2 shows the plan of the air-transport system to the several groups of heating surfaces. The scale indicates the long distances traversed from the powdered-coal mill to the furnace. It is of interest to note that the transport lines through which the powdered coal is brought are 4 in. in diameter throughout the plant. It is believed that this fact is conducive to greater economy, as compared with screw conveyors or large-cross-section air mains now in use.

To regulate the powdered coal fed to the furnace, controllers are provided at the bottom of the hopper, one for each burner (Fig 3). The controller consists of a cast-iron hopper casting bolted to the opening with a spiral screw which feeds the fuel accurately to a cast-iron screen housing spaced from the hopper casting by a steel pipe. At the front of the hopper casting the thread of the spiral screw is interrupted in order to admit of the movement of two simultaneously operated gates controlled by levers on the outside, which regulate the amount of coal carried to the burners by varying the gate opening. By this device exact feed of fuel is accomplished, and it is stated that a controller of 500-tons-of-coal-per-hour capacity has been adjusted to feed a minimum of 26 lb. per hour.

The burner is composed of a large cast-iron pipe with a specially shaped elbow. The coal-dust pipe is concentric

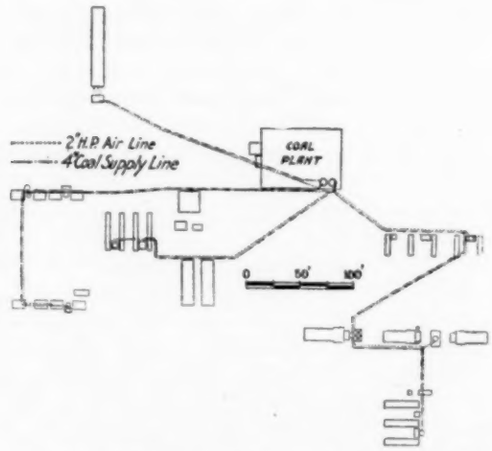


FIG. 2 PLAN OF AIR-TRANSPORT SYSTEM TO SEVERAL GROUPS OF HEATING FURNACES

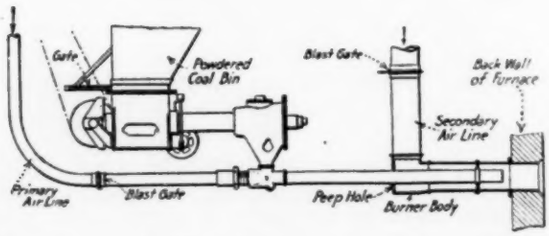


FIG. 3 APPARATUS FOR REGULATING FUEL FED INTO BURNER

within it and extends almost to the furnace wall. The air for combustion enters through the elbow under 1.25 oz. pressure, and the air transporting the coal under a pressure of 6 oz. expands down to 1.25 oz., mingling with the combustion air at that pressure as it burns.

The furnace temperature is regulated by the amount of coal passed into the burner through the gate controller and by the quantity of air. It is stated that air firing at the low pressure of 1.25 oz. is desirable as it reduces the abrasive action on the brickwork. (*The Iron Age*, vol. 101, no. 9, February 28, 1918, pp. 545-549, 7 figs., *e*)

THE MELTING POINT OF COAL ASH, J. T. Dunn. A brief report of a highly interesting investigation giving the melting points of a number of ashes.

It has been found that the melting point of ashes is essentially determined by the quantity of basic oxides, especially alumina and silica, and the molecular weight of same, so that if one adds to the given mixture of alumina and silica a quantity of another metallic oxide the amount by which the melting point is lowered is almost independent of the nature of the material, provided its quantity is proportionate to its molecular weight; and that if a number of different oxides are mixed together with the alumina and silica mixture at the same time, the reduction of the melting point depends upon the number of molecules of the oxides which have been added to the given number of molecules of alumina and silica. (*Journal of the Society of Chemical Industry*, vol. 37, no. 1, January 15, 1918, pp. 15 T-16 T.)

TESTING AND STANDARDIZATION OF MOTOR FUEL, E. Lawson Lomax. The writer begins by giving an interesting classification of the hydrocarbons present in motor fuel. He proceeds then to the description and discussion of comparative merits of testing. In connection with the determination of the boiling point he thus discusses the methods of Sir Boverton Redwood and a modification of the Engler method for the valuation of crude petroleum, and also submits his own method, which combines the ease of manipulation of the Redwood test with the precision of the Engler test.

He also describes a method for approximately determining the sulphur compounds in the fuel, a matter of importance, because sulphur frequently reacts with the metal of the carburetor.

The determination of the hydrocarbon characteristics is discussed in considerable detail; while in connection with the determination of the spontaneous-ignition temperature only, the Moore method is described, which is a test consisting of allowing one drop of the fuel to fall into a platinum crucible heated to a desired temperature and observing whether an explosion occurs. (*Journal of the Institution of Petroleum Technologists*, vol. 4, no. 13, December 1917, pp. 6-25, 2 figs.)

DRY AND WET COAL IN HOUSE-HEATING BOILERS, J. J. Light. *The Pennsylvania State College Bulletin*, vol. 11, no. 14, November 15, 1917, pp. 148-152, 2 tables.

EMPIRICAL METHOD OF ANALYSIS OF COAL, J. P. Calderwood. *The Pennsylvania State College Bulletin*, vol. 11, no. 14, November 15, 1917, pp. 127-147, 6 tables.

HOW FUEL MAY BE SAVED. *Power*, vol. 47, no. 9, February 26, 1918, pp. 306-308.

Furnaces

GAS FURNACES AS RE-HEATERS OF IRON PILES, ETC., George Carrington. *The Iron and Coal Trades Review*, vol. 96, no. 2606, February 8, 1918, pp. 150-151.

Hydraulics

DETERMINATION OF THE DUTY OF WATER BY ANALYTICAL EXPERIMENT, W. C. Hammatt. The purpose of the paper is to show a method used in the determination of the quantity of water required for the growth of certain crops, where it is impracticable to measure it directly. In this case it was desired to determine the duty of water for the propagation of certain wild grasses in southeastern Oregon, under conditions making it impracticable to segregate certain measured areas and determine the actual use of water. Therefore some other method had to be devised, and the analytic method was selected as probably the best.

This method consisted in dividing the water into its various uses and making a separate determination, as far as possible, of each use. In this manner any of the determinations which were based on estimates, or for which the data were inadequate or unreliable, would affect only the particular item concerned, and not the whole duty of water. Also, by a study of different factors making up the analysis, it is believed that unnecessary or reparable losses may be discovered.

In this case the water was to be used for plant growth. In a strict sense the only water actually so used is that taken in through the roots and either remaining as a component part of the plant or evaporated through its leaves. However, it is impossible to deliver water to the roots directly, and as the water has to pass through the soil, both on its way to the plant and in order to pick up the salts necessary for plant growth, the uses of water are subdivided into the following four classes: (1) Soil moisture; (2) Soil evaporation; (3) Plant use; (4) Soil losses.

The writer proceeds to the analysis of each one of these items in a manner which cannot be reported here through lack of space.

The writer claims that while the method here described is not always superior to that of direct trial, it is useful in cases where the latter is impracticable, and even where direct trial is possible it may be used as a check on the economy of consumption of water for irrigation purposes. (Paper presented on March 20, 1918, before the American Society of Civil Engineers, abstracted from *Proceedings of the American Society of Civil Engineers*, vol. 44, no. 2, February 1918, pp. 307-357, 23 figs., *ep*)

Internal-Combustion Engines

THE ENGINES OF THE ZEPPELIN AND THE GOTHA. *The Engineer*, vol. 125, no. 3243, February 22, 1918, pp. 157-160, 19 figs.

FUEL CONSUMPTION OF LOW-COMPRESSION OIL ENGINES, L. H. Morrison. *Power*, vol. 47, no. 11, March 12, 1918, p. 367.

Lubrication

LUBRICATION OF BALL BEARINGS, Otto Bruenauer. The present article begins by setting forth the principal characteristics of oils and greases such as may be used for lubrication of bearings, especially ball bearings, and then proceeds to the description of various types of designs for grease, oil and dirt-proof houses. The article, which is apparently the beginning of a series, is liberally illustrated and is of considerable practical interest.

As regards the intervals at which the ball bearings must be lubricated, the writer states that in shaft hangers, in industrial motors, wheel hubs, gear cases, pumps and machines operating under similar conditions a fresh charge of lubricant twice a year is ample and in some cases once a year will be found sufficient. Exposure of the machine to heat will make more frequent lubrication necessary. Also for railway motors, journals and such machines as are constantly exposed to the influence of weather and outdoor conditions a fresh charge of lubricant four to six times a year is recommended. (*American Machinist*, vol. 48, no. 8, February 21, 1918, pp. 316-322, 18 figs.)

ON THE LUBRICATING AND OTHER PROPERTIES OF THIN OILY FILMS, Lord Rayleigh. *The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*, Sixth Series, vol. 35, no. 206, February 1918, pp. 157-163. An experimental investigation of great interest, an abstract of which will be given in an early issue.

Machine Shop

GRINDING HOBS TO REMOVE DISTORTION, Edward K. Hammond. *Machinery*, vol. 24, no. 7, March 1918, pp. 585-589, 13 figs.

GENERAL THREAD CUTTING PRACTICE IN THE LATHE, Franklin D. Jones. *Machinery*, vol. 24, no. 7, March 1918, pp. 634-639, 9 figs.

EFFECT OF IMPROVED MECHANICAL CONTRIVANCES ON THE CONSERVATION OF MEN. *Railway Review*, vol. 62, no. 7, February 16, 1918, pp. 231-233.

ÉTUDE SUR LA FABRICATION DES CENTRES DE ROUES DE WAGONS PAR L'EMPLOI D'UN LAMINOIR A CINQ CYLINDRES, M. Leon Geuze. *Revue de Métallurgie*, 14e Annee, no. 6, November-December, 1917, pp. 717-729, 12 figs. Description of a method of machining railway carwheel hubs by means of a special device described in the article.

Machine Tools

GAG PUNCH FOR STRUCTURAL PUNCH PRESS, J. V. Hunter. *American Machinist*, vol. 48, no. 7, February 14, 1918, pp. 274-276, 6 figs.

CUTTER FOR SPUR AND HELICAL GEARS, W. F. Mallory. *The University of Colorado Journal of Engineering*, vol. 14, no. 2, January 1918, pp. 37-43, 3 figs.

DIFFERENTIAL MOTIONS AND PLANETARY GEAR COMBINATIONS, Franklin D. Jones. *Machinery*, vol. 24, no. 7, March 1918, pp. 600-604, 9 figs.

Measurements

MEASURING HIGH PRESSURES WITH DEAD WEIGHT, Sanford A. Moss, Mem.Am.Soc.M.E. Description of the use of a dead-weight pressure-gage tester for measuring pressures during tests, as used in the Steam Turbine Department of the General Electric Company, Lynn, Mass.

The difficulty with Bourdon pressure gages when extreme accuracy is desired, is that frequently the calibrations before and after the test disagree, and even where the calibrations do agree there is often a question as to whether the temperature effect has been properly taken care of. In addition, most Bourdon gages are not accurate to one per cent, and therefore have to be read by estimation between the graduations.

The dead-weight pressure gage consists of an accurately bored cylinder, usually having an area of ⅛ sq. in., with a closely fitting piston, at the top of which is a platform on which are placed weights sufficient to keep the gage floating. For use in direct measurement of pressure a stop must be added to prevent the piston from rising out of the cylinder, and an oil trap and reservoir, so that there should at all times be oil in contact with the cylinder and piston. The platform and piston must always be spun by hand when the apparatus is in use.

This gage when attached directly to the pipe where pressure is being measured gives without any difficulty whatever readings accurate to within 0.25 of one per cent. Fig. 4 shows the

apparatus used in the Turbine Department of the General Electric Company's works at Lynn, Mass., where there are about fifteen outfits, all in more or less regular use. Fig. 5 gives a sectional view through the dead-weight pressure gage.

The writer describes in detail several measurements where the dead-weight pressure gage is used. He states in particular that in orifice tests of pumps for air compressors it is necessary to have two dead-weight gages; or one dead-weight gage and one mercury column, since there are two distinct pressures. One of these is a discharge pressure measured in the pipe between the throttle valve and the machine; it gives

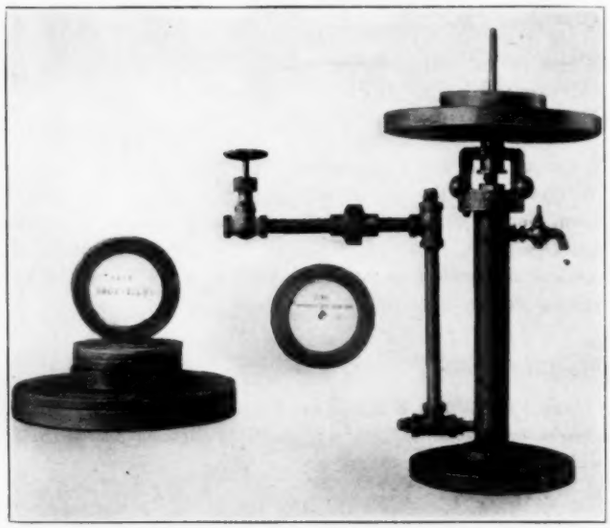


FIG. 4 DEAD-WEIGHT PRESSURE GAGE

the pressure with which the machine is to be credited in computing performance, efficiency, etc. The throttle valve cuts down this pressure so that any desired pressure can be had on the orifice, the volume or amount of flow being computed from the orifice pressure. This orifice pressure may be measured by means of a static hole in the pipe wall with the pipe connecting to the dead-weight gage or mercury column, or an impact tube may be used on the jet discharged from the orifice, as explained in a paper by the author, entitled The Impact Tube (Trans.Am.Soc.M.E., December 1916).

When, in the test with the dead-weight gage, the pressure variation is such as to require constant adjustment by an attendant, a throttle valve must be provided at a convenient location and the gage must be piped nearby. The attendant then has one hand on the throttle valve and with the other hand spins the dead-weight gage. The purpose of this spinning is to keep the gage floating.

The writer gives two tables from which the necessary corrections in the readings may be made, as well as directions to avoid errors in readings. (*Power*, vol. 47, no. 9, February 26, 1918, pp. 286-288, 3 figs., *dA*)

NEW "TOTAL-IMMERSION" HYDROMETER, A. Ängstrom and H. Pettersson. (*Zeits. Instrumentenk*, 37, pp. 177-180, September, 1917). To a glass bulb, weighted with shot, and of about 25 cm.³ external volume, is attached a fine chain about 40 cm. long. The chain is made of doubly-gilded brass and contains about 500 links of equal weight. When a bulb and chain are put into a glass cylinder containing a liquid of such density that the bulb is totally immersed, the bulb will sink in the liquid and the chain will coil up on the bottom of the cylinder until a position of equilibrium is reached. The cylinder containing the liquid is so graduated that the density of the liquid in it can be determined from the position of the pointed upper end of the glass bulb. It is shown that the maximum error in the density is less than the accuracy with which the divisions on the cylinder can be read, the average error not exceeding 0.02 per cent. If the bulb is made of quartz, the chain of gold, and a Dewar vacuum vessel is used to contain the liquid, an accuracy of about 0.002 per cent can be obtained. It is convenient to have a glass cylinder with a false bottom on which the chain coils up. The bottom of the cylinder is drawn out to a tube and fitted with rubber tubing and clip so that the liquid can be conveniently run out. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 1, no. 241, January 31, 1918, p. 1)

FLOW MEASUREMENT IN A WATER COLLECTING GALLERY BY THE CHEMICAL METHOD, D. H. Maxwell. *Journal of the American Water Works Association*, vol. 4, no. 2, June 1917, pp. 192-199, 3 figs.

Mechanics

HOW TO PROPORTION UNSYMMETRICAL CONCRETE ARCHES, Jos. P. Schwada. The writer develops a method and formula for determining the dimensions of the two halves of an unsymmetrical concrete arch.

One of the steps in the design of an unsymmetrical concrete arch is the proportioning of the arch ring. This consists of the determination of the position of the crown with respect

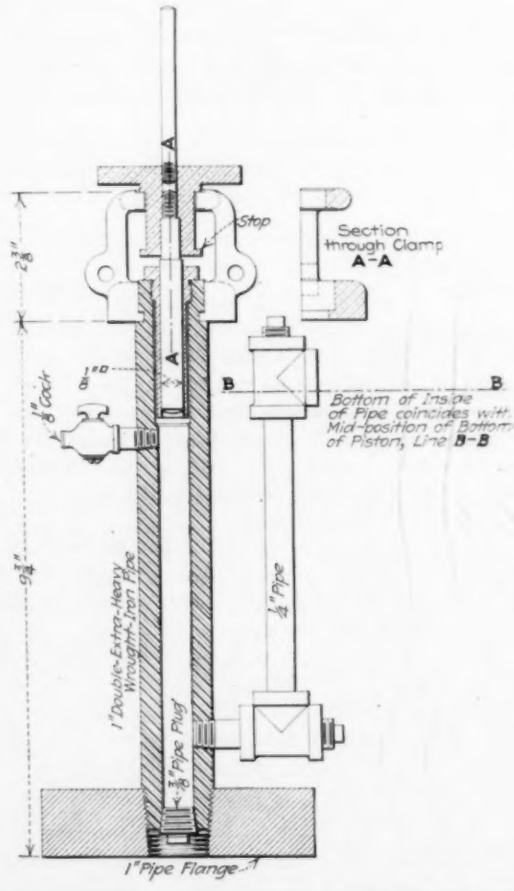


FIG. 5 SECTIONAL VIEW THROUGH DEAD-WEIGHT PRESSURE GAGE

to the springing lines and the selection of a proper crown thickness, the curvature of the arch axis and the thickness of the arch ring from the crown to the springing lines. An empirical method is here offered for determining these dimensions. This method is based on a consideration of an unsymmetrical arch ring as made up of half spans of unequal symmetrical arches, located so that when treated as the half spans of symmetrical arches, the crown thrusts for dead load only will be equal. Hence, the position of the crown will be at the point of zero shear, and the crown thickness, curvature of the arch axis and the thickness of the arch ring may be obtained as for symmetrical arches.

The writer derives an expression for the length of the shorter segment of the unsymmetrical arch of given span, and also an expression for the other determining magnitudes. A comparison between the crown thrust for a given unsymmetrical arch determined according to the elastic theory, and the crown thrust for the symmetrical arches, with half spans equal to the segments of the unsymmetrical arch, determined according to both the empirical formula and the elastic theory, shows the general reasonable correctness of the empirical formulæ. (*Engineering News-Record*, vol. 80, no. 9, February 28, 1918, pp. 415-416, 3 figs., *pe*)

STUDIES OF LIQUID FILMS, Sir James Dewar. Last year Sir James Dewar delivered a lecture before the Royal Institution on liquid films (soap bubbles), and showed the great importance of research in this direction. He pointed out at the time that the work was threatened by the restriction of the departmental staff. While his two men actually remained in with him, the research was frequently interrupted.

The speaker explained the manner of blowing the soap bubbles and means for prolonging their life, the most important in this latter respect being the absence of dust, and especially of greasy dust specks. He further explained the mechanics of the bubble: namely, thinning of the film through the draining off of the liquid of the bubble and the condensation of water vapor on the film, resulting in the washing out of the soap.

The gas pressure inside the bubble was always a little greater than the pressure outside. Owing to the surface tension, the bubbles contracted and the gas was forced outward through the film.

In order to produce large bubbles of long life, the speaker attempted to purify one of the cellars of a building of all dust and blow bubbles from outside through the wall. The cool, steady temperature of such a space was supposed to be an advantage. Actually, however, the attempts failed. Yet Sir James succeeded in producing films, one half black and another wholly black, in a bottle about a foot and a half in diameter. One of these films lived for 56 days, in spite of all the vibrations of the laboratory.

Two methods have been applied to prevent the spontaneous contraction of a bubble and to prolong its life. One is to replenish the gas forced out of the bubble, and the other to produce the bubble in a high-pressure atmosphere, so as to have a high pressure both inside and outside of the bubble. Thus, in the case of a bubble in a glass vessel at ten atmospheres pressure, ten times the amount of gas would have to get through the film to produce the same contraction as would result in a container at atmospheric pressure, while in a container at 100 atmospheres the bubble would practically be permanent. Rates of transference of hydrogen through bubbles under a pressure of 1 atmosphere and 6.5 atmospheres were determined.

Sir James also made numerous experiments on the production of chains of bubbles, showing how bubbles united. One of the ways of determining this was as follows:

By forcing air through a tube he produced a soap bubble on a plate of glass smeared with glycerine, the bubble being more or less hemispherical. When a second bubble was planted next to the first, the second united with a plane common face; a third bubble added led to the formation of three common faces meeting at 120 deg., and so on. When the plate was illuminated from below to show the arrangement in the plan, it was seen that five bubbles would group themselves about a pentagon; six bubbles would form a hexagon, etc. When the plate was blown upon, the films collapsed and flattened out, but the geometric pattern remained discernible for a few moments.

In another series of tests, a chain of bubbles was suspended from a tube forming quite interesting structures, including catenaries of strange complexity built up of multitudes of bubbles in regular patterns. For example, an inclined catenary in which photographs of natural colors showed both the spherical and the color plane faces. (Lecture before the Royal Institution, January 18, 1918, abstracted through *Engineering*, vol. 105, no. 2717, January 25, 1918, pp. 98-99, 1 fig., *etA*)

LA DÉTERMINATION GRAPHIQUE DES ENGRENAGES HÉLICOIDAUX, P. Massot. *La Technique Moderne*, Tome 10, no. 1, January 1918, pp. 8-13, 4 figs. Graphical determination of helicoidal gears.

Metallurgy

THE VISCOSITY OF BLAST-FURNACE SLAG AND ITS RELATION TO IRON METALLURGY, INCLUDING A DESCRIPTION OF A NEW METHOD OF MEASURING SLAG VISCOSITY AT HIGH TEMPERATURES, Alexander L. Field. *Transactions of the Faraday Society*, vol. 13, parts 1 & 2, December 1917, pp. 3-35, 8 figs., 10 tables.

LES FORMULES NOUVELLES EN MÉTALLURGIE LE LONG-FOURNEAU POUR LA PRODUCTION DE LA FONTE, Amédée Sébillot. *Revue Scientifique, Industrielle et Commerciale des Metaux & Alliages*, 11th year, no. 1, January 1918, pp. 1-3, 1 fig. Discussion of some new formulæ in metallurgy. The present investigation is based on the formula developed just before the war by the Russian metallurgist, Prof. Groun Grzimailo. On the basis of this formula the writer has developed a new type of blast furnace.

Motor-Car Engineering

PRINCIPLES OF TRACTOR-ENGINE COOLING, Arthur B. Modine. Discussion of the factors involved in tractor-engine cooling. While the paper is specifically devoted to tractor engines, it discusses the subject in a broad manner, which makes it fully applicable to the case of motor-engine cooling generally.

The principal variables affecting the cooling in addition to the radiator size pertain to radiator type, radiator core, thickness or degree of cooling capacity, rate of water circulation, size, type and speed of fans, and the economic characteristics of the engine to be cooled.

It is obvious that in order that the cooling should be efficient, the air has to be capable of taking away the heat delivered in the water to the radiator. This heat to the radiator, as the author states in his introductory formula, is equal to heat input minus heat equivalent of horsepower developed and

heat losses, which he divides into two groups, viz.: exhaust loss, and engine radiation and convection losses.

The following equation is given as derived from observed average performances:

$$\text{Heat to radiator} = 0.40 \times \text{heat input} \times F$$

where F is a variable with the value of 1.0 in the case of L-head engines ranging from 25 to 50 hp. and 0.8 in the case of valve-in-head engines of the same power range, both values applicable to tractors. The writer shows further that in the case of a tractor, the heat loss to the radiator per minute per horsepower is equal to about 100 B.t.u. It may be stated here that the average heat loss to the radiator in motor-car engine design is assumed to vary from 50 to 60 B.t.u. per min. per hp.

The writer derives the following formula for the frontal area of the radiator in sq. ft. per hp. output of the engine:

$$\text{Area} = \frac{6000}{v(T_4 - T_3)}$$

where v is the air velocity in ft. per min. and $T_4 - T_3$ is the temperature rise of air (in deg. fahr.) due to its passage through the radiator.

This indicates that for a given radiator the problem of cooling resolves itself into two factors—the temperature rise of the air and the velocity of the air.

The writer considers the subject of temperature rise in its relation only to two variables—rate of water delivery and air velocity; and shows, first, that the velocity of flow of water through the radiator is of very great importance, the faster flow producing much better cooling; and second, that the heat taken up by convection by air increases nearly directly in proportion to the velocity.

The paper presents also an interesting discussion as to fan power requirements, and presents a plea for larger fans and slower speeds than those in present average practice. (*Journal of the Society of Automotive Engineers*, vol. 2, no. 2, February 1918, pp. 148-151, 4 figs., *et*)

TRACTION ON BAD ROADS OR LAND, L. A. Legros. *Engineering*, vol. 105, no. 2717, January 25, 1918, pp. 86-89, 13 figs. (to be continued).

CAMION AUTOMOBILE POUR LE TRANSPORT DES ORDURES MÉNAGÈRES ET DE MATÉRIAUX QUELCONQUES, L. Archinard. *Bulletin Technique de la Suisse Romande*, 44e Annee, no. 1, January 12, 1918, pp. 1-6, 15 figs. Description of a European design of a motor truck for the conveyance of sewage.

Munitions

FORMULÆ FOR TRAJECTORIES OF ANTI-AIRCRAFT SHELLS, G. Manetti. The formulæ used in the present article are expressed in the notation used in the works on ballistics by Siacci and by Ronca, published in Italy. These works are not available in the Library of the Engineering Societies.

Consider the two trajectories in Fig. 6, such that $X = W$, $OC = OD$ and the initial velocity V is the the same in both cases. Then from the equations cited by Ronca, the writer deduces the following equations:

$$X = \frac{V^2 \sin 2\phi_x}{g} G_y(Z) \quad \ldots\ldots [1]$$

$$W = 2V^2 \frac{\cos(\varepsilon + \alpha)\sin\alpha}{g\cos^2\varepsilon} G_y(z) \quad \ldots\ldots [2]$$

From the condition stated above, namely, $OD = OC$, the writer deduces $OB = x = X\cos\varepsilon$, but knowing that approximately $\beta = \sec\phi$, he further deduces that the ballistic coefficient of the trajectory OC is equal to the ballistic coefficient of OD multiplied by the same $\cos\phi$. Hence, $z = Z$, and $G_y(z) = G_y(Z)$.

After simple reductions the following formula is obtained:

$$\sin 2\phi_x = \frac{2\cos(\varepsilon + \alpha)\sin\alpha}{\cos^2\varepsilon} \quad \ldots\ldots [3]$$

and by an analogous method, assuming that T_w represents the duration corresponding to W, he obtains

$$T_w = T \cdot \frac{\cos\varepsilon\cos\alpha}{\cos(\varepsilon + \phi_x)} \quad \ldots\ldots [4]$$

These are the formulæ which have already been deduced by another method, namely, by a consideration of the analogy with motion in vacuum by Obermeyer, Schmidt, Clausen and others, together with the following formula which is correct only for vacuum:

$$\tan\vartheta = \tan(\varepsilon + \alpha)\frac{\sin 2\phi_x \cos\varepsilon}{\cos^2(\varepsilon + \alpha)} \quad \ldots\ldots [5]$$

But knowing that $\nu = \varepsilon - \vartheta$, Clausen advises to substitute the value of the angle of arrival of the aerial trajectory when ν is calculated by these vacuum formulæ and to multiply the result by ϕ_x/ω_x, a procedure which has no analytic justification, but is permissible in an approximate calculation. (Compare *Journal of the United States Artillery*, November-December 1916).

The preceeding formulæ represent the best approximative solution of the problem of anti-aircraft ballistics, because of their marked simplicity, and in computations give sufficiently satisfactory results, which may be improved to any desired degree by means of the following methods:

From [3] it is easy to obtain equation

$$\frac{2d\phi_x}{\tan 2\phi_x} = \left[\frac{1}{\tan\alpha} - \tan(\varepsilon + \alpha)\right] d\alpha \quad \ldots\ldots [6]$$

a formula to the application of which it is possible to give a precision equal to that which is secured with its integral. This can be proved in the same manner as has already been done with respect to the function G. Since it is known that $\frac{2d\phi_x}{\tan 2\phi_x} = \frac{\tan\omega_x}{\tan\phi_x}\frac{dX}{X}$, which is true because by assumption $X = W$, and hence $dX = dW$, we have

$$\frac{\tan\omega_x}{\tan\phi_x}\frac{dW}{W} = \frac{1}{\tan\alpha} - \tan(\varepsilon + \alpha)d\alpha \quad \ldots\ldots [7]$$

which is the differential equation of projection on the plane and is of great value in the calculation of tables of fire.

From the equality of $G(z) = G(Z)$ is derived also the equality of their partial derivatives $\frac{\partial G}{\partial V} = \frac{\partial G}{\partial \frac{x}{G}}$ and hence by the usual differentiations of [1] and [2] it is easy to prove that approximately the following two equations always hold good:

$$\frac{\partial W}{\partial V} = \frac{\partial X}{\partial V} \quad \ldots\ldots [8]$$

$$\frac{\partial W}{\partial C'} = \frac{\partial X}{\partial C'} \quad \ldots\ldots [8a]$$

These equations are of the greatest utility for direct application and still more for purposes indicated below.

It is known that

$$\frac{\tan\omega_x}{\tan\phi_x}\frac{dX}{X} = \frac{2d\phi_x}{\tan 2\phi_x} + \frac{\tan\omega_x - \tan\phi_x}{\tan\phi_x}\frac{dC'}{C'}$$

Knowing that

$$\frac{2d\phi_x}{\tan 2\phi_x} = \frac{\tan \omega_x - \tan \phi_x}{\tan \phi_x} \frac{d\,\delta}{\delta}$$

and introducing this value into Equation [6], we obtain

$$\frac{\tan \omega_x - \tan \phi_x}{\tan \phi_x} \frac{d\,\delta}{\delta} = \left[\frac{1}{\tan \alpha} - \tan (\varepsilon + \alpha)\right] d\alpha$$

which permits improving the result obtained by the application of [3] (which may be done in practice by using a nomographic slide rule) by applying the angles of elevation directly in order to take care of the variation of density in the vertical direction.

Professor Fubini has succeeded in an original and ingenious manner to establish the following equations:

$$d\phi = g \frac{dy - \tan \theta\, dx}{V^2(\tan \phi - \tan \theta) + \frac{\partial x}{\partial V} \tan \theta \left(g \tan \phi + \frac{\partial i}{C} F(V) \frac{1}{\cos \phi}\right)}$$

from which we get by writing $dy = 0$, ...[9]

$$V^2\left(1 - \frac{\tan \phi}{\tan \theta}\right) = g \frac{\partial x}{\partial \phi} + \frac{\partial x}{\partial V} V \left(g \tan \phi + \frac{\partial i}{C} \frac{F(V)}{\cos \phi}\right). \quad [10]$$

By using the same method the present writer succeeded in obtaining

$$V^2 \left(\frac{\sin \alpha}{\tan \nu} - \cos \alpha\right) = g \cos \phi \frac{\partial W}{\partial \alpha} + V\left(g \sin \phi + cf(V)\right) \frac{\partial W}{\partial V}$$

.....[11]

in which the ballistic coefficiency for the sake of convenience in anti-aircraft fire calculations is, contrary to the usual practice, expressed by the following equation:

$$c = 0.896 \frac{a^2}{p} \delta_m i$$

where δ_m is the average density; 0.896 i is the "form" coefficient as applied to a projectile of the type having a complete ogive of two radial calibers.

The three formulæ, [9], [10] and [11], are of the greatest utility for purposes of calculation.

In tables of anti-aircraft firing preëminent importance must be given to fuse timing. Hence, while the above formulæ may be considered to have the same values as if they were expressing at the same time a formal solution of problems of anti-aircraft ballistics, they cannot be correctly applied to the case of formula [4]; that is, to the calculation of all "time" elements.

In the Italian *Rivista di Artiglieria e Genio* two papers concerning the above matter were published in 1916 and 1917, first by the author and then by the well-known artillerist, Bianei. In the present article the author proceeds to give a more simple and direct solution than any given in the two papers cited above.

If we consider that at P, Fig. 7, is projected some point of an anti-aircraft trajectory which is being calculated, then by adhering to the hypothesis of direct resistance and by applying the Siacci formulæ for retardation as given in Ronca's Ballistica (in formulæ 54 on p. 149), and finally by resolving the force of gravity into two forces—one parallel to, and the other at right angles to, the direction of motion, the writer applies the principle of conservation of energy and obtains

$$\frac{dv}{dt} = \frac{vdv}{ds} = -cf(v) - g \sin \theta$$

and for centripetal acceleration

$$\frac{v^2}{\rho} = \frac{v^2 d\theta}{ds} = -g \cos \theta$$

where ρ is the radius of curvature. From this we easily deduce

$$ds = \frac{-vdv}{g \sin \theta + cf(v)}$$

$$dt = \frac{-dv}{g \sin \theta + cf(v)}$$

$$d\theta = \cos \theta \frac{gdv}{v[g \sin \theta + cf(v)]}$$

Substituting for $\frac{c}{\sin \theta}$ the expression, $c_1 = \frac{c}{\sin \theta_m}$ where θ_m is the average value of θ, we obtain

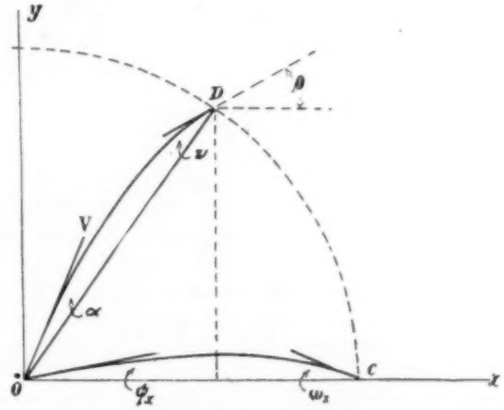


Fig. 6 Trajectories of Anti-Aircraft Shells Having the Same Initial Velocity

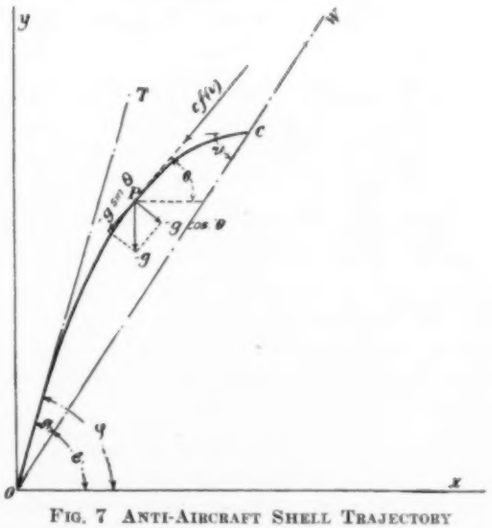


Fig. 7 Anti-Aircraft Shell Trajectory

$$\log_e \frac{\cos \theta}{\cos \phi} = \int_V^v \frac{-gdv}{v[g + c_1 f(v)]}$$

Then, using the notation

$$B(v) = \int_v^{1200} \frac{gdv}{v[g + c_1 f(v)]}$$

and further using the notation $e^{B(v)} = I(v)$, the writer obtains

$$\cos \theta = \cos \phi \frac{I(v)}{I(V)}$$

Likewise it is easy to deduce

$$s = \frac{1}{\sin \theta_m}\left[S(v) - S(V)\right]$$

$$t = \frac{1}{\sin \theta_m}\left[T(v) - T(V)\right]$$

where

$$S(v) = \int_v^{1200} \frac{v\,dv}{g + c_i f(v)}$$

$$T(v) = \int_v^{1200} \frac{dv}{g + c_i f(v)}$$

Now, since $dy = \sin \theta ds$ and $dx = \cos \theta ds$ we have $y = \sin \delta_m s$

$$\text{and } dx = \cos \phi \, \frac{I(v)}{I(V)} \, \frac{-v\,dv}{g \sin \theta + cf(v)}$$

and hence

$$x = \frac{\cos \phi}{I(V)} \, \frac{1}{\sin \theta_m} \left[A(v) - A(V) \right]$$

where

$$A(v) = \int_v^{1200} \frac{I(v) v\,dv}{g + c_i f(v)}$$

There is no difficulty in calculating and tabulating with respect to v and c_i the functions I, A, S and T, and this will give a complete solution of the problem provided the method of calculating the average function $\sin \theta_m$ be given.

The writer considers it unnecessary to try to solve this far more difficult part of the problem, since, from a practical point of view, the results would be of little value. As a matter of fact, tables can be constructed so as to make the interpolation very easy, and it is always possible in practice to use such a subdivision as would make it possible to give with reasonable correctness to $\sin \theta_m$ such a value that the function $\sin \theta$ may apply to the origin of the required arc. (*Rivista Maritima*, vol. 50, no. 10, October 1917, pp. 29-38, 2 figs. *tmA*)

MANUFACTURE OF THE U. S. 75-MILLIMETER SHELL, Erik Oberg. *Machinery*, vol. 24, no. 7, March 1918, pp. 590-596, 15 figs. First installment of a very interesting series of articles. The discussion is of a purely practical nature.

GAS WARFARE, S. J. M. Auld. *Scientific American Supplement*, no. 2200, March 2, 1918, pp. 142-144.

POISONOUS GAS IN WARFARE: APPLICATION, PREVENTION, DEFENSE, AND MEDICAL TREATMENT. *Professional Memoirs, Corps of Engineers, United States Army and Engineer Department at Large*, vol. 9, no. 48, November-December, 1917, pp. 758-784.

THE MANUFACTURE OF THE LEWIS MACHINE GUN, Frank A. Stanley. *American Machinist*, vol. 48, no. 7, February 14, 1918, pp. 265-273, figs. 12-20 (Part 2). Continuation of description of the details of manufacture of the Lewis machine gun, a valuable contribution of a practical nature.

THE MADSEN AND BERGMAN, 1915, MODELS OF AUTOMATIC RIFLES USED BY THE GERMAN INFANTRY. *Professional Memoirs, Corps of Engineers, United States Army and Engineer Department at Large*, vol. 9, no. 48, November-December, 1917, pp. 706-707, 2 figs.

MANUFACTURING TIME FUSE RINGS, Donald A. Baker. *Machinery*, vol. 24, no. 7, March 1918, pp. 612-614, 6 figs.

HOW SEMISTEEL SHELLS ARE BEING MADE IN FRANCE, E. Ronceray. *The Foundry*, vol. 46, no. 3 (whole no. 307), March 1918, pp. 93-96. *The Iron Trade Review*, vol. 62, no. 11, March 14, 1918, pp. 666-668. Paper on the manufacture of cast semi-steel shells, based on the French.

TESTS OF BROWNING MACHINE GUNS. *The Iron Age*, vol. 101, no 10, March 7, 1918, p. 629.

MANUFACTURING BASE PLUGS FOR THE 80 MARK VIII TIME FUSE, John Campbell. *American Machinist*, vol. 48, no. 10, March 7, 1918, pp. 414-417, 18 figs.

PRESSURE, STATICAL AND DYNAMICAL, F. W. Jones. *Arms and Explosives*, vol. 26, no. 305, February 1, 1918, pp. 20-22, 2 figs. The question of the statical and dynamical pressures is here applied to the design of lead crushers. The article is an interesting contribution to this comparatively little known subject.

MANUFACTURE OF THE 75-MM. HIGH EXPLOSIVE SHELL, S. A. Hand. *American Machinist*, vol. 48, no. 11, March 14, 1918, pp. 435-439, 9 figs.

HEAT-TREATING 3-IN. SHRAPNEL SHELLS. *American Machinist*, vol. 48, no. 11, March 14, 1918, pp. 441-442, illustrated.

Power-Plant Engineering

WASTE PREVENTION IN POWER PLANTS, Victor J. Azbe. *The Iron Trade Review*, vol. 62, no. 7, February 14, 1918, pp. 421-428, 13 figs.

NINETY-FIVE THOUSAND KILOWATT ADDITION TO NORTHWEST STATION. *Power*, vol. 47, no. 11, March 12, 1918, pp. 354-358, 6 figs.

Pumps

RELIABILITY OF PUMPING STATION DESIGN, Clarence Goldsmith. *Journal of The American Water Works Association*, vol. 4, no. 4, December 1917, pp. 432-446.

SOME COSTS OF MAINTENANCE OF MOTOR-DRIVEN DEEP-WELL PUMPS, Melvin L. Enger. *Journal of the American Water Works Association*, vol. 4, no. 2, June 1917, pp. 190-191, 2 tables.

SOME TESTS ON MOTOR-DRIVEN DEEP-WELL PUMPS, I. W. Fisk and P. S. Biegler. *Journal of the American Water Works Association*, vol. 4, no. 2, June 1917, pp. 239-251, 9 figs.

Railroad Engineering

ELECTRIC BOILER HEATING FOR STEAM LOCOMOTIVES, W. Kummer. (*Schweiz. Bauzeitung*, 1917. *Elektrot. u. Maschinenbau*, 35. pp. 434-435, Sept. 9, 1917. Abstract). This article suggests that electric boiler heating offers economic advantages on Swiss steam railways; there are also criticisms by other writers. Kummer considers that electric heating can compete with coal firing for boilers at the present price of coal in Switzerland. Any kind of current may be employed so long as it is transmitted at high enough pressure. The accompanying table gives data for three types of Swiss steam railways referred to traffic in ton-km. (total weight).

Assuming feedwater at 30 deg. cent., the heat expenditure for steam as used on locomotives averages 635 kg-cal. per kg. for saturated steam and 700 kg-cal. per kg. for superheated steam. On the basis of 1 kg-cal. = 1.16 watt-hr., and allowing 86 per cent efficiency for saturated steam or 81 per cent for superheated steam between the line feeding point and the steam

raised, we have an energy consumption of 857 watt-hr. per kg. with saturated steam, and 1000 watt-hr. per kg. with superheated steam. Lines 3 (*a*), (*b*) in the table show the much higher efficiency of direct electric drive, compared with electric heating of steam boilers. Lines 4 (*a*), (*b*) are based on lines (1) and (3), and on coal at 100 fr. per ton and electrical energy at 1.5 Rp, per kw-hr. Under these conditions electric heating is 10 per cent cheaper than coal firing. Allowing 0.043 to 0.055 Rp. per ton-km. for working line costs, and from 0.015 to 0.01 Rp. per ton-km. for the conversion of steam locomotives to electric heating, the cost of electric heating would be practically equal to that of coal firing. Kummer suggests that tests be made on an electric railway with a steam locomotive fitted for electric heating.

	Rhaetian Railway	Gotthard Railway	Swiss Mountain Railways, Circuits 1 to 4
1 Coal consumption, kg. per ton-km.	0.100	0.080	0.075
2 Steam consumption, kg. per ton-km.:			
(*a*) Using saturated steam	0.700	0.560	0.525
(*b*) Using superheated steam	0.600	0.480	0.450
3 Electrical energy at feeding-point of the line, watt-hr. per ton-km.:			
(*a*) Steam boiler heating	600	480	450
(*b*) Direct electric drive	48.1	46 to 47	45 to 46
4 Cost of steam, rappen per ton-km.:			
(*a*) Coal firing	1.00	0.80	0.75
(*b*) Electric boiler heating (excluding working cost for line, and loco. conversion)	0.90	0.72	0.675

L. Thormann criticises the practicability of the proposed system. This writer allows 1 kw-hr. per kg. of steam at working pressure; and an energy consumption with electric boiler-heating equal to about 10 times that with electric locomotives. If there is a heating surface of 250 m.² already available on the locomotive to be converted, approximately another 650 m.² would have to be provided, with a construction weight of 52 tons. Probably the extra weight of the electrically heated boiler would be 60 to 80 tons, excluding transformers, which would probably be necessary, and would add another 80 tons to the dead weight. The crucial point seems to be the heating surface required. Thormann's estimate is much higher than Kummer's, owing partly to his assuming that there is no considerable heat storage, so that the heat equivalent of electrical energy supplied would have to correspond with the instantaneous steam demand. Thormann concludes that the weight of an electrically heated boiler and locomotive would be two or three times that of an ordinary steam locomotive; the former would be costly and increase materially the specific energy consumption, so that energy would have to be obtainable at 1.5 centimes (rappen) per kw.-hr. to compete with coal firing. This price, at the line wire, cannot be realized.

In his reply, Kummer asserts that 2750 kw. at the line would provide 417 hp. at the wheel rim of an electrically heated locomotive, sufficing to propel a total weight of 350 tons at 25 km. per hr. up a 1:100 gradient. Thormann's assumption of 917 m.² heating surface for 1036 hp. (at rim) corresponds to 1.13 hp. per m.², whereas 4 to 6 hp. per m.² is commonly obtained with locomotive boilers providing saturated steam, and 6 to 8 hp. per m.² with superheated steam. Kummer does not agree that the locomotive weight would be much increased by electric heating; as compared with plain electric drive, the electrically heated boiler would be able to accumulate energy during station stops and while running downhill.

A. Trautweiler suggests that surplus electrical energy if available free, could be used advantageously to preheat feedwater for locomotives up to 90 deg. cent. or so in stationary plants at depots. At a medium-sized depot 250 m.³ of feedwater might be required daily for 20 locomotives. If 5000 kw. spare capacity be available for 5 hr. each night at an adjacent power station, this could be utilized (at 80 per cent efficiency) to warm the 250 m.³ of feedwater through 70 deg. cent. This would correspond to a saving of 3000 kg. coal per diem. Even on the basis of peace prices for coal, this saving would cover the costs and charges on the preheating equipment. (*Science Abstracts*, Section B—Electrical Engineering, vol. 21, pt. 1, no. 241, January 31, 1918, pp. 1-2)

A SCIENTIFIC STUDY OF RAILWAY TRACK UNDER LOAD. Progress report of investigations carried on for a period of over five years by a special joint committee of the American Society of Civil Engineers and the American Railway Engineering Association.

The proper conception of the fundamentals underlying the action of track under load may be had only by considering the track as an elastic structure under load. The wheel loads are applied on the top of the rails; the rails are flexible beams which rest on flexible supports (ties); and the ballast and roadway on which the ties rest are themselves yielding or flexible. Due to the stiffness of the rail and the yielding of its supports, the load from a wheel will be distributed over a number of ties, and the amount of yielding of the supports affects the values of the moments and stresses developed in the rail.

The properties of elasticity and stiffness in the rail, the tie, the ballast and the roadway enter in a complex manner into the development of the stresses in a track structure, the relative stiffness of the various parts affecting the results in any one part. The spacing of the wheels of locomotives and cars longitudinally along the track also influences the division of the load, and hence the value of the stresses developed in rails, ties and ballast.

The method of analysis of track action, which is based on the assumption of a continuous elastic support under the rail, has been found to be the most convenient and most comprehensive in its applications to the present investigation. The assumption of a continuous support in place of tie supports is not an element of serious inaccuracy for the close tie spacing and large rail sections used on the American railroads.

A new term, "modulus of elasticity of rail support," has been introduced to measure the vertical stiffness of the rail support, and may be defined as the pressure per unit of length of each rail required to depress the track one unit. It represents the stiffness and ability to yield of tie, ballast and roadway, but does not involve the stiffness of the rail. As applied to ordinary track, the load on one rail required to depress one tie one unit, divided by the tie spacing, will give the modulus of elasticity of rail support.

The fundamental condition on which the analysis is based is that the track depression at any point and the upper pressure of the rail per unit of length at the same point are directly proportional to each other; in other words, $p = uy$.

The following notation is used here (compare Fig. 8):

P = wheel load on a rail at the point which will be used as the origin of abscissæ

E = modulus of elasticity of steel

I = moment of inertia of section of the rail

y = depression of rail at any point, x, it being assumed that there is no play or backlash in the track; downward displacement of a rail is negative; however, in the applications to track, the ordinary downward depressions of track will be spoken of as positive

p = upward pressure against rail per unit of length of rail at any given point

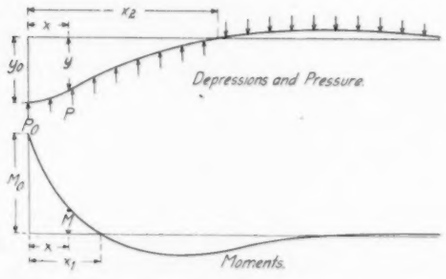


FIG. 8 DISTRIBUTION OF DEPRESSION AND BENDING MOMENT FOR A SINGLE LOAD

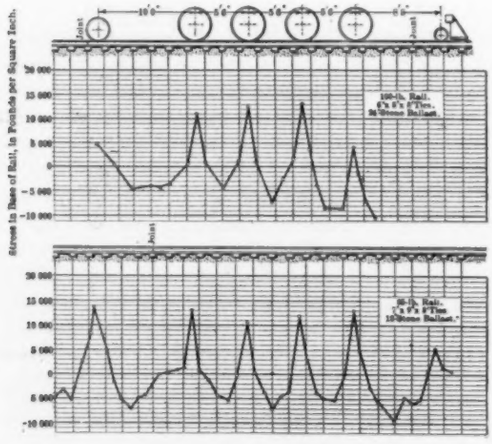


FIG. 9 STRESS-DISTRIBUTION DIAGRAMS FOR STATIC-LOAD TESTS WITH MIKADO LOCOMOTIVE

u = an elastic constant which denotes the pressure per unit of length of each rail necessary to depress the track (rail, tie, ballast and roadway) one unit; for the system of units ordinarily used, it will be expressed in pounds per inch of length of rail required to depress the track 1 in.; u represents the stiffness of the track, and involves conditions of tie, ballast and roadway; it is termed the modulus of elasticity of rail support

M = bending moment in rail at any point.

The formulæ for the bending moment in the rail, the shear and the intensity of the pressure (p) against the rail are obtained from the differential equation of equilibrium of a beam. To find the effect of a combination of wheel loads on the track depressions and the pressures and the bending moment in the rail as may occur with the given type of locomotive, the equations and diagrams for a single wheel load may be applied by the use of the principle of superposition; that is, by considering that at the given point along the rail the combined effect of two or more wheel loads is the algebraic sum of the effects of the individual wheel loads.

Two main types of tests were carried out: namely, static-load tests and moving-load tests. In all moving-load tests, except at very low speeds, steam was shut off as the locomotive approached the test section of the track. It was found that the tractive effort of the locomotive produced an appreciable effect on the rail stresses which was somewhat variable, and it was decided to eliminate this variable when the effect of speed only was studied.

As regards depression of track, little difference was found in the depression for the load over a tie and for the load midway between ties, though both in the one-axle and two-axle loads the depression is generally somewhat greater for the load overhead tie. There is a marked difference, however, in the magnitude of depression, according to the condition of the track, freshly tamped track having a smaller depression under load than track which has been subjected to the action of traffic for a considerable time after surfacing.

Load-stress diagrams for gage lines at the point of application of load in the case of one-axle load and at the points of application of load in the case of two-axle loads were secured and the average of the stresses at the two points being plotted in the latter case. Here again little difference is to be found in the rail stress under the load for a load over a tie and for a load midway between ties, but rail stresses differ noticeably, according to the condition of the track, freshly tamped track giving small stresses. For a rail of 85-lb. section, the stress in rail in an untamped track was found to be as much as 6000 lb. per sq. in. more than in a freshly tamped track.

An interesting series of static-load tests was carried out with a Mikado locomotive on rails of 85-lb. and 100-lb. sections. The static distribution diagrams shown in Fig 9 have been derived from these tests. It is found that the maximum stresses in the rails are directly under the wheels, positive moment being developed at these points and negative moments at points between the wheels. The stress under the inner two drivers and that under the front driver is generally somewhat greater than that under the real driver.

Values of the modulus of elasticity of support were calculated from the track depressions expressed in pounds per inch of rail length necessary to depress the track one inch.

There seems to be some tendency toward a higher value of the modulus in the track having the heavier strain. It is apparent that the character and condition of the track greatly influences the magnitude of the modulus of elasticity of rail support.

Tables were compiled showing the effect of speed as a percentage of the stress in the rail at 5 m.p.h. for each mile-per-hour increase of speed greater than 5 m.p.h. In this connection it appears that heavier rail sections give a somewhat higher proportional increase of stress with increase of speed than the lighter sections; also the heavier rail gives a much higher bending moment coefficient than the lighter. (*Proceedings of the American Society of Civil Engineers.*)

NEW 2-6-4 TYPE TANK LOCOMOTIVE SOUTHEASTERN & CHATHAM RAILWAY. *The Railway Gazette,* vol. 28, no. 6, February 8, 1918, pp. 159-164, 7 figs.

SCREW SPIKES UNSATISFACTORY ON PENNSYLVANIA LINES. *Engineering News-Record,* vol. 80, no. 9, February 28, 1918, p. 413.

CAUSES OF SPLIT-HEADS IN RAILS. *The Iron Trade Review,* vol. 62, no. 9, February 28, 1918, pp. 544-547, 6 figs.

WHEEL CONTACTS ON RAILHEADS, George H. Barbour. *Proceedings of The Engineers' Society of Western Pennsylvania,* vol. 33, no. 8, November 1917, pp. 489-522, 22 figs.

A New Scale Test Car, A Christopher. *Railway Age*, vol. 64, no. 7, February 15, 1918, pp. 371-372, 1 fig.

Internal Strains in Steel Rails, James E. Howard. *New England Railroad Club*, January 8, 1918, pp. 279-305. Further presentation of the valuable results experimentally secured by the present writer.

La Contre-Vapeur sa Puissance son Emploi Actuel, M. A. Herdner. Description and extensive discussion of a counter-pressure brake. This brake, while practically unknown on British and American railways, has still a certain amount of application on French and especially Spanish and Italian lines. It operates by using the engine as an air compressor driven by the weight or momentum of the train, and is of some value on railroads operating with head grades. *Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils de France*, Bulletin de Juin-Septembre 1917, 8 Serie, 70 Annee, nos. 6-9, pp. 523-631, 67 figs., 10 tables.

The Kearney High-Speed Railway, E. W. Chalmers Kearney. *Journal and Transactions of the Society of Engineers*, vol. 8, no. 12, December 1917, pp. 307-356, illustrated.

A New Locomotive Superheater Header. *The Railway Gazette*, vol. 28, no. 7, February 15, 1918, p. 188. Description of a simplified header in which there are no special fastening device, fittings and appliances for the insertion and removal of steam tubes.

Dynamic Augment—Need and Means of Reducing It, E. W. Strong. *Official Proceedings of the New York Railroad Club*, vol. 28, no. 4, pp. 5183-5229, 6 tables.

Intensive Locomotive Development, O. S. Beyer, Jr. *Railway Mechanical Engineer*, vol. 92, no. 3, March 1918, pp. 131-133 (to be continued).

Resilient Chairs and Ferro-Concrete Sleepers. *Engineering*, vol. 105, no. 2721, February 22, 1918, pp. 191-193, 16 figs.

Refrigeration

Relation between Efficiency of Refrigerating Plants and the Purity of Their Ammonia Charge, F. W. Frerichs. An extensive experimental investigation in which it is shown that the quality of the ammonia charge has an important bearing upon the operation of the ice plant. In order to minimize considerable losses due to operation of absorption in ice machines with impure ammonia, the writer recommends using liquid anhydrous ammonia of known purity and pure distilled water for charging absorption plants. He calls further attention to the fact that the question of purity of water is of real importance. (*The Journal of Industrial and Engineering Chemistry*, vol. 10, no. 3, March 1, 1918, pp. 202-211, 7 figs., 4 tables.)

The Economy of a Refrigerating Power Plant, Victor J. Azbe. *Journal of The Engineers' Club of St. Louis*, vol. 3, no. 1, January-February 1918, pp. 6-21, 11 tables.

Research

The Aerodynamic Laboratory at Leland Stanford Junior University and the Equipment Installed, with Special References to Tests on Air Propellers, Prof. Wm. F. Durand. *Aerial Age Weekly*, vol. 6, no. 24, February 25, 1918, pp. 1070-1072.

U. S. Metals Refining Co.'s New Laboratory at Chrome, N. J., B. B. Hood. *Engineering and Mining Journal*, vol. 105, no. 10, March 9, 1918, pp. 451-454, 5 figs.

Industrial Research Laboratories, F. K. Richtmyer. *The Sibley Journal of Engineering*, vol. 32, no. 6, March 1918, pp. 80-81.

Research and the Industries, P. G. Nutting. *The Sibley Journal of Engineering*, vol. 32, no. 6. March 1918, pp. 81-84.

A Mixed Pressure Steam Turbine. *Power Plant Engineering*, vol. 22, no. 5, March 1, 1918, pp. 195-197, 2 figs.

Steam Engineering

A 50,000 Sq. Ft. Condenser. Description of a surface condenser serving a 30,000-kw. turbine. One of the interesting features of its construction is the use of a special design of expansion joint, shown in Fig. 10. It is 13 ft. in diameter and consists essentially of a fairly close-fitting cast-iron sleeve, so formed as to permit a manometric column of mercury to make a seal to prevent air leakage and at the same time permit of a free motion of the upper and the lower halves of the joint relative to each other. The upper part of the joint is built so that if, for any reason, the mercury arrangement should fail, an ordinary slip joint with soft packing could be used, the place for it being indicated in the figure as "Rope for Packing."

The dotted portion marked "Expansion Joint Clamping Block" at the lower left part of the figure is not used when the joint is in service. It is simply an arrangement whereby the two portions of the joint can be fastened together for shipment, and is removed after the joint is in place.

Some such type of joint was necessary, because the great vertical distance between the condensers and the turbines entailed an extraordinarily great expansion in case the apparatus should be much changed in temperature. The mercury expansion joint can take up an indefinite amount of expansion, whereas a copper joint might ultimately fail with the great distortion necessary. (*Power*, vol. 47, no. 9, February 26, 1918, pp. 282-285, 4 figs., *d*)

The 50,000-Kilovolt-Ampere Connors Creek Turbines. The Connors Creek plant of the Detroit Edison Company was planned to contain six 25,000-kva. machines. Three of them were installed between 1915 and 1917, but when the fourth unit came up for consideration it was found that the development of large turbine units had progressed to such a point that it would be desirable to install a unit of greater capacity than originally planned. Hence, instead of the original contemplated 25,000-kva. units it was decided to install two 50,000-kva. machines, one of which is now being placed.

This turbine is of the disk type. It has twenty-one stages as against nine in the smaller machines, but is only 15 ft. longer overall than are the smaller machines. Other dimensions are also much smaller than one would expect from a direct comparison of capacities. The weight is only about 40 per cent greater than that of the earlier models, while the speed of 1200 r.p.m. is the same.

The small physical size in comparison with the earlier units is partly due to refinements in design, which have made it possible to greatly decrease the distance between wheels and also

to generate higher voltage, viz., 12,200 instead of 4600. The tremendous capacity in a single turbine barrel and in a single generator is given by the size of the exhaust opening, which is rectangular and measures 12 by 18 ft. in the clear. The unit is supplied with steam through two lines, each 14 in. in diameter, and the steam from the exhaust passes directly downward through a short expanding neck into the condenser, which, like the turbine, is the largest yet attempted in a single shell. It is also unique among condensers of this general class in that it is arranged for but one water pass. The circulating water enters all the tubes at one end and leaves all at the other end, flowing away over a dam, the crest of which is so located as to submerge the highest tubes.

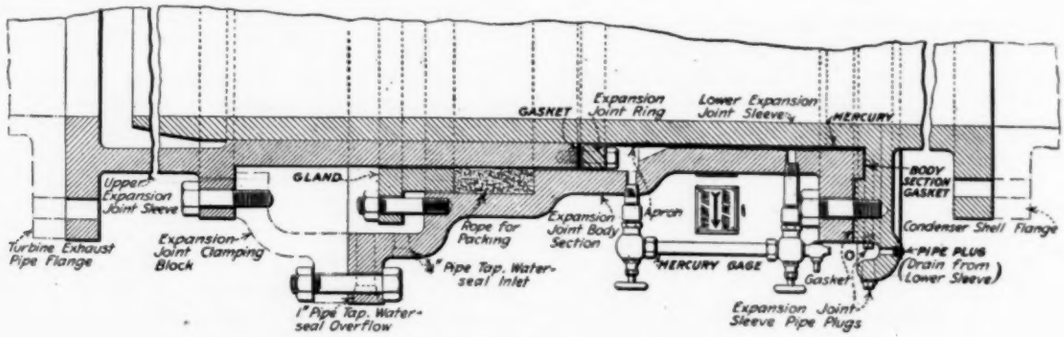


FIG. 10 DETAILS OF THE MERCURY EXPANSION JOINT FOR CONDENSERS

In order to prevent an excessive cooling of the condensate, special devices called drain plates were installed. These drain plates are formed by placing light-weight metal plates in the steam space in such positions as to catch the condensate from the upper sections and lead it to the bottom of the condenser without allowing it to come in contact with the tubes in the sections through which it is led. These plates are not intended as steam guides or baffles, and their successful use depends on placing them in such positions that they do not interfere in any manner with the free flow of steam. (*Power*, vol. 57, no. 8, February 19, 1918, pp. 255-256, *d*)

STEAM-RAISING BY ELECTRICITY, WITH HEAT STORAGE, E. Höhn (*Schweiz. Bauzeitung*, 69., April 28, 1917. *Elektrot. u. Maschinenbau*, 35. pp. 316-317, July 1, 1917. Abstract). Describes tests made in October, 1916, by the Swiss Union of Boiler Owners, on a boiler in which steam was raised electrically. A horizontal cylindrical boiler with flat ends had 28 steel tubes of 27 and 28 mm. diam. and 1250 mm. free length. The effective heating surface in contact with water was 4.25 sq. m. (34 tubes), the permissible steam pressure 2.5 atmos. Each of the 34 active tubes contained a spiral nichrome wire threaded through glass beads and about 54 m. long, 0.9 mm. diam. and with a specific resistance of 1 to 1.1 ohms. For convenience in control, the heating spirals were arranged in groups of 18, 9 and 7. Approximately the current consumption was 145 amp. at 225 volts. The evaporation in two tests was 12.8 and 13.5 kg. per hr. per sq. m. heating surface, and 1.212-1.205 kg. per kw.-hr., respectively. The thermal efficiency of the boiler is 89.8-90.5 per cent.

In order to work economically, plenty of cheap electrical energy is needed; this may be secured by applying waste power to steam raising and storing heat on the principle of the fireless locomotive. The author discusses the economy of such an installation in which 100 hp. of waste power is converted to heat during 12 hours and stored in this form. As regards the size of storage necessary: If E = available energy in kw-hr., A = heat equivalent = 859 kg-cal. per kw-hr., and η_1 = efficiency of evaporation; then heat W transferred to steam = $\eta_1 EA$, and if t = feedwater temperature and i = heat content of saturated steam, we have weight of steam = G kg. = $\eta_1 EA/(i-t)$. Further, let Q be the number of kg. of water in reservoir before discharge, D the weight in kg. of steam evaporated from the accumulator during discharge, t_2 = the temperature of the feedwater, w_2 = its heat content (= t_2), t_3 the temperature of water and saturated steam in accumulator at pressure p_2 after discharge, w_2 and i_2 the heat contents of water and steam, respectively, t_1 the temperature of water and saturated steam at pressure p_1, after charging, and w_1, i_1 the heat contents of water and steam. Then the heat remaining in the accumulator after discharge = $Q - D$. The charging heat = $EA\eta_1 = Q(w_1 - w_2) + D(w_2 - w_3)$. The amount of Q which can be "self-evaporated" as steam is $D = Q(w_1 - w_2)/(i_m - w_2)$. Hence $Q = EA\eta_1/[w_1 - w_2 + x(w_2 - w_3)]$. Knowing the weight of water, Q, the volume is easily calculated.

Applying these equations to the above numerical example, we have the heating surface = 7.5 m.² corresponding to a boiler 800 mm. in diam., 1600 mm. between tube plates, with 47 tubes of 27/32 mm. diam. The accumulator water content Q = 9370 kg. and the total accumulator volume V = 11.8 m.³, corresponding to a cylindrical vessel of 1.5 m. internal diam. and 6 m. high. The weight of steam removable from the accumulator is D = 1020 kg. The efficiency of the accumulator is 94-95 per cent, and of the whole installation, including boiler, 82 per cent. Of the electrically generated steam G = 1020 kg., 960 kg. can be recovered from the accumulator, corresponding to a coal economy of about 130 kg. per day. This covers interest and depreciation and leaves a small margin for current cost. If there is no direct charge for current supply, the plant may be used even to accumulate heat on Sunday for use during the rest of the week. Neither boiler nor accumulator requires any appreciable attendance. (*Science Abstracts, Section B*—Electrical Engineering, No. 24, December 31, 1917, pp. 435-436)

Thermodynamics

THE GAS-FILM THEORY IN RELATION TO HEAT CONDUCTION, Halbert T. Gillette, Mem.Am.Soc.M.E. The writer starts by citing a statement by Prof. H. L. Callendar on the adherence of gas films to solids, and the paper by Irving Langmuir (1912), where he showed that the film of quiescent air adhering to incandescent wires is 0.17 in. thick. This led the present writer to make some experiments with the view to determining the film thickness of water.

He found that at low temperatures and in water not mechanically stirred, the equivalent film thickness of water is about 0.05 in.

Next the writer undertook to determine the equivalent film thickness of steam. In this respect he has not yet secured sufficient experimental data to deduce a formula for all conditions, but claims to have established the fact that the equivalent film thickness of steam is far less than that of air, which, if correct, is of material importance.

In its simplest form, the film theory of the writer is graphically illustrated in Fig. 11. There a temperature gradient is shown from t_1 to t_4 through two gas or liquid films and a solid. This figure represents heat conduction from a gas or liquid through a solid to a gas or liquid. Heat flows from a temperature t_1 through a film of thickness d_1 to a solid, which it enters at a temperature t_2, dropping to t_3 and thence to a temperature d_3. While the actual heat gradients through gases or liquids

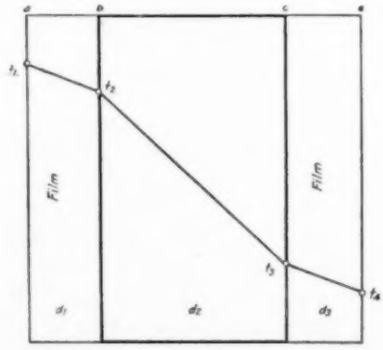


FIG. 11 DIAGRAMMATIC ILLUSTRATION OF THE FILM THEORY

are not straight lines, for simplicity's sake each film is here assumed to conduct heat exactly as if it were a solid. This may be legitimized by the use of the term "equivalent film thicknesses." If by H we denote the number of heat units that pass through this system in one hour, by k_1, k_2 and k_3 the coefficients of heat conductivities of the respective films, the equation

$$d_1 = k_1 \frac{t_1 - t_2}{H}$$

will give the equivalent film thickness when the other factors are known. Usually t_2 is not known directly, but if we know H, d_3 and k_3, we may calculate $t_2 - t_3$ from the equation

$$t_2 - t_3 = \frac{H d_3}{k_3}$$

and from this we can readily deduce t_2, or if the films are of the same gas or liquid, the drop in each film. Also, t_3 can often be measured.

The writer calculates the amount of heat which will pass through a glass window from a room whose temperature is 70 deg. fahr. to quiescent air outside at a temperature of 50 deg. fahr., assuming that the plate of glass is 1 ft. sq. and ⅛ in. thick. This calculation is based on a table reproduced in the original article and giving coefficients of heat conductivity for a large number of solids, liquids and gases. The author shows that while the total temperature drop is 20 deg., only 0.2 deg. is the share of the drop through the glass, while 19.8 deg. is the drop through the two air films, which clearly shows the extent of resistance to heat transfer offered by the air films as compared with glass an eighth of an inch thick. This result was secured, however, only by ignoring the heat lost by radiation from the surface of the glass.

Further, the influence of the air film decreases rapidly when the air is mechanically agitated, as when the wind is blowing or powerful convection currents take place. This is one of the reasons why double windows or double glazing is so effective in reducing heat losses. In a double window there are four air films instead of two, and a strong wind can reduce the thickness of only one of the four.

In his analysis of available experimental data on heat transfer, the author was struck with the slight resistance offered by steam. By deduction he secured for steam a coefficient of conductivity not greatly differing from that for air at the same temperature, but found that steam transfers heat many times faster than does air, which, in his opinion, is possibly only because the equivalent film thickness of steam is much less than that of air. Water in the ashpit of a boiler has long been known to increase fuel efficiency under certain conditions. The author believes that the reason for it is that the steam film facilitates the transfer of heat through the boiler tubes to the water and steam film on the other side.

Brief indications are given as to the method of applying the film theory as exposed here to the design of windows and heat-insulated walls. In particular, as to the latter, the writer designed a heat insulator in which the walls are hermetically sealed, and the space between filled with granular or fibrous material and a gas of low conductivity, such as CO_2 or SO_2. Such a gas-filled insulator has more than double the heat resistance of an ordinary air-film insulator of equal thickness. (*Engineering and Contracting*, vol. 47, no. 26, June 27, 1917, pp. 573-576, *et A.*)

THERMODYNAMICS OF THE THROTTLE VALVE, M. Jakob. (*Phys. Zeits.* 18., pp. 421-422, Sept. 15, 1917.) This paper is a discussion of a previous communication by R. Planck [see Abs. 146 (1917)]. From his formula [1], namely:

$$v/T = c^{\circ}_p 10^4 \cdot A \cdot \int 1/T^2 \, (\delta A/\delta p) \, rdT + f(p)$$

Planck derived the following equation of state [2] for the air:

$$v = RT/10^4 \cdot p - 0.0103\,(8.9/T^{3.75} - T^2 + 15p^2/T^6)$$

and then deduced an expression [3] for the cooling produced during reduction to atmospheric pressure by the throttle valve:

$$\triangle = -17.8_p/T + {}^{2.5}{}^{6}{}^{p}/T^2 - {}^{m}p^{3}/T^3.$$

Schames has shown [*ibid.* p. 30, 1917] Equation [2] to give false values for the volumes, and Planck's reply to his criticism [Abs. 314 (1917)] was that his empirical equations only held in the region of — 100 deg. to 0 deg. cent., and from 70 deg. to 200 deg.; even within this zone, however, v deviates too strongly from observation values and at the higher pressures by over 10 per cent. Schames has not supplied the cause of this variation in Equation [1], and in the present paper this is shown to be essentially due to the assumption made by Planck for $f(p)$. In order to modify formula [1] so as to hold between wide limits, Equation [3] must be suitably replaced by one of greater validity. Planck's assumption that $f(p) = R/10^4 p$, is found to be only correct when the conditions are those for a perfect gas. The author evolves a value for $f(p)$ which gives results correct in practice to 1 per cent. Schames's criticism is also met by a suitable modification of Equation [3]. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 1, no. 241, January 31, 1918, pp. 26-27. The formulæ [1], [2] and [3] above are given as printed in *Science Abstracts*.—EDITOR.)

THE NERNST THEOREM AND THE THERMAL EXPANSION OF SOLID BODIES, M. B. Weinstein. (*Ann. d. Physik*, 53, 9. pp.

47-48, October 2, 1917). In a former communication [Abs. 520 (1917)] the author has shown that on the Planck view of Nernst's theorem it does not of necessity follow that the thermal expansion of bodies, for which the theorem is valid, is nil at the absolute zero of temperature. In the present paper the author proceeds to deduce the same result from Nernst's exposition of his own theorem. The author refers to his own work on the equation of state for solid bodies, where a similar result is found for many substances. Reasons are given why Nernst's statement of his own theorem is considered preferable of that of Planck. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 1, no. 241, January 31, 1918, p. 23)

ON THE NERNST THEORY OF HEAT, P. S. Epstein. (*Ann. d. Physik*, 53, pp. 76-78, October 2, 1917). Weinstein has recently [Abs. 520 (1917)] investigated Planck's explanation of Nernst's theory of heat. This he has modified to the extent of finding that the entropy of a condensed body at absolute zero is not an absolute constant but may be dependent on the pressure. The present author now puts forward a thermodynamical exposition of this proposition, and this points to Weinstein's assumption being incompatible with the second law of thermodynamics. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 1, No. 241, January 31, 1918, p. 23)

HEAT TRANSMISSION THROUGH BUILDING MATERIALS, J. A. Moyer, J. P. Calderwood and M. P. Helman. *The Pennsylvania State College Bulletin*, vol. 11, no. 9, September 1, 1917, pp. 55-62, 4 figs., 3 figs.

Varia

THE FORCES WHICH ACT UPON A TRANSMISSION LINE, Charles R. Harte. *Electric Railway Journal*, vol. 51, no. 8, February 23, 1918, pp. 364-366, 1 fig.

SCRAP METAL BALING PRESS. *Engineering*, vol. 105, no. 2718, February 1, 1918, pp. 114-115.

POST-WAR RECONSTRUCTION ARRANGEMENTS. *Engineering*, vol. 105, no. 2718, February 1, 1918, pp. 123-125, 1 fig.

TABLES DE DIVISION, H. Chevalier. *Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils de France*, 8e Serie, 70e Annee, no. 6, Bulletin de Mai 1917, pp. 402-420.

THE APPLICATION OF MECHANICAL DIFFERENTIATION TO ENGINEERING PROBLEMS, Armin Elmendorf. *Journal of The Franklin Institute*, vol. 185, no. 2, February 1918, pp. 269-276, 2 figs.

OFFENSIVE AGAINST THE SUBMARINE, Joseph A. Steinmetz. *The Journal of the Engineers' Club of Philadelphia*, vol. 35-2, no. 159, February 1918, pp. 69-80, illustrated.

SPLASHER SYSTEM COOLS ARTESIAN WATER-SUPPLY. *Engineering News-Record*, vol. 80, no. 5, January 31, 1918, p. 210.

THE "PROS AND CONS" OF THE METRIC SYSTEM, L. B. Atkinson. *The Journal of The Institution of Electrical Engineers*, vol. 56, no. 271, February 1918, pp. 121-128.

THINKS FEDERATION OF STRONG LOCAL SOCIETIES NEEDED FOR ENGINEERING UNITY. *Engineering News-Record*, vol. 80, no. 10, March 7, 1918, pp. 452-454.

A CASE FOR THE ADOPTION OF THE METRIC SYSTEM (AND DECIMAL COINAGE) BY GREAT BRITAIN, A. J. Stubbs. *The Journal of The Institution of Electrical Engineers*, vol. 56, no. 271, February 1918, pp. 129-135.

LIST OF SHIPBUILDERS. *The Iron Age*, vol. 101, no. 10, March 7, 1918, pp. 621-623.

HANDLING ORDNANCE SUPPLIES. *American Machinist*, vol. 48, no. 10, March 7, 1918, pp. 405-410.

DELORO SMELTING & REFINING CO., LTD., DELORO, ONT., THE HOME OF STELLITE. *Canadian Machinery*, vol. 19, no. 10, March 7, 1918, pp. 231-235, 14 figs.

L'UTILISATION APRES LA GUERRE DES USINES CRÉÉES POUR LES BESOINS DE LA DEFENSE NATIONALE, FABRICATION D'OBJETS AGRAFES, M. Lunet. *Le Génie Civil*, Tome 72, no. 8, February 23, 1918, pp. 134-138, 38 figs.

EMERGENCY METHODS OF CUTTING AND DRILLING GLASS DISKS, J. A. Lucas. *American Machinist*, vol. 48, no. 11, March 14, 1918, pp. 451-452, 5 figs.

DUST PREVENTION ON HIGHWAYS, H. B. Shattuck. *The Pennsylvania State College Bulletin*, vol. 11, no. 15, December 1, 1917, pp. 153-162.

THE BY-PRODUCT OVEN—A PARADOX, William H. Blauvelt. *The Iron Trade Review*, vol. 62, no. 11, March 14, 1918, pp. 659-664, 5 figs.

Charts

ALIGNMENT CHARTS, George L. Hedges. *Machinery*, vol. 24, no. 7, March 1918, pp. 615-618.

FARM TRACTOR ENGINEERING CHARTS, Joseph Jandesek. *The Gas Engine*, vol. 20, no. 3, March 1918, pp. 114-116 and 118.

ALIGNMENT CHART FOR FEEDS, SPEEDS AND POWER OF LATHE TOOLS, A. Lewis Jenkins. *American Machinist*, vol. 48, no. 11, March 14, 1918, p. 457.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

The city of Philadelphia has awarded the John Scott Legacy Medal and Premium to Max Ulrich Schoop, of Zurich, Switzerland, for the Schoop Metal Sprayifig Process. In this process, wire of some easily fusible metal, like zinc, is fed into a device called a spraying pistol. The wire passes through a tube, and at its end comes into contact with burning gas, by which it is melted, and the molten metal is sprayed by an air blast upon the surface to be covered. The use of this process has been found to greatly increase the life of patterns for castings.

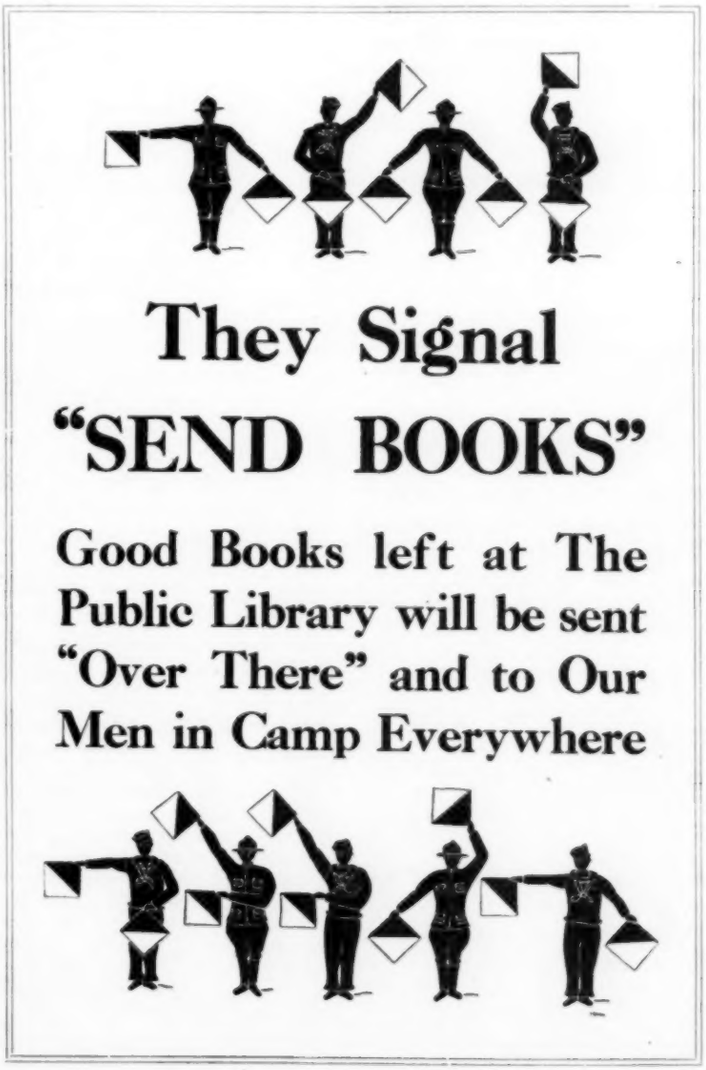
LIBRARY NOTES AND BOOK REVIEWS

ARTICLES of interest from the Library of the four Founder Societies, selected list of accessions during the month, and reviews of books of special importance prepared by members of the A.S.M.E. and others particularly qualified.

WAR LIBRARY SERVICE

GOOD books are urgently needed for our soldiers and sailors here at home in the training camps, on transports, in the Navy and overseas in the trenches.

A fund of $1,700,000 has been raised by the American Library Association to build and equip thirty-four libraries in the camps, to provide trained library service, and to buy books. The service includes all Y. M. C. A., K. of C. and Y. M. H. A. huts, hospitals, Y. W. C. A. hostess houses, and many other distributing agencies. The work has grown wonderfully, and to supply the unexpectedly great demand for books and thriftily save the fund, the American Library Association calls for gifts of books from the public.



Every camp librarian reports a steady, large demand for technical works of every class. The war is an engineers' war, and the need for engineering data is acute. The American Library Association intends to devote its funds as far as possible to the purchase of scientific and technical books and other works of a serious nature, but it will appreciate greatly any gifts of this kind, as well as of recreational reading.

Over 600,000 books are now in use, but hundreds of thousands more are needed. Multitudes of good books that would be of the greatest service are standing unused on shelves in our homes. Others that are treasured would be given gladly if the great need were known. Many useful engineering works stand on office shelves, not in actual use and rapidly growing obsolete. Their presentation to the Army would be a real service. Obviously, the technical books sent should be recent editions.

To present books, all that is necessary is to mark them "War Library Service" and deliver them at any public library. They will be forwarded to the war-library storage plant and distributed to the points where they are most needed.

HARRISON W. CRAVER.

BOOK REVIEWS

The Taylor System in Franklin Management: Application and Results. By Major George D. Babcock, in collaboration with Reginald Trautschold, with a foreword by Carl G. Barth. The Engineering Magazine Co., New York, 1917. Cloth, 5½x8½ in., 265 pp., 26 figs., including 4 folding charts. $3.

Aside from the real merit which this book possesses as an exposition of scientific management, it is very interesting because it gives a fairly full account of the introduction and building up of one of the best-known successful installations of the Taylor methods, namely, in the plant of the H. H. Franklin Manufacturing Company. Considerable of the subject-matter was published originally in *Industrial Management*, but it has, of course, been edited and supplemented for this volume.

The first two chapters are devoted to the conditions in the Franklin plant in 1908 prior to the introduction of the new system and to the investigation and reasoning that led to the installation of scientific management, so-called. Chapters III, IV and V treat of the methods by which the product was classified and the methods by which the flow of product was controlled. The complex-appearing control board invented by Major Babcock is described fully, as well as other features of the control and dispatching system.

Chapter VI discusses employment and rate fixing. Chapter VII describes the Franklin organization, while Chapter VIII discusses how changes in product and method are handled.

Chapter IX, entitled Changes That Have Affected the Men, is most interesting in that the author concludes that the Taylor system as operating at the Franklin plant is far from a mechanical system, so far as men and women are concerned, as is usually supposed. On the other hand, he claims that it is distinctly human and brings out the best there is in all workers. The concluding chapter shows how the results of the plant operations are depicted graphically.

In addition to these chapters there are two appendices. The first, entitled Wage Rates in the Franklin Shops, gives some specific experiences with the wage system discussed in the chapter on employment and rate setting. The second appendix is devoted to suggestions concerning the best form of scientific management for repair shops, small-part factories and plants with uniform manufacture.

One of the most interesting chapters is that on employment and rate fixing. It describes an interesting though complex attempt to fix the worker's compensation by taking account of all the variables such as the percentage of increase in cost of living. Like all such efforts it rests upon the prevailing wage rates, and the author very sagely points out that no successful attempt has as yet been made to fix an accurate base rate. The important feature of the chapter, however, is the attempt on the part of the management to do what was fair. Perhaps this attempt had considerable to do with the success of the whole plan.

The book is filled with useful information for those who wish to study these new methods. It is true that the conditions of manufacture in the Franklin shops lend themselves more readily to the Taylor system than do many others, but all manufacturers and students of efficiency can read this book with profit.

DEXTER S. KIMBALL.

The Taylor System of Scientific Management. By C. Bertrand Thompson. A. W. Shaw Co., New York, Chicago and London, 1917. Flexible cloth, 9x11 in., 175 pp., 43 illustrations and 22 forms, charts and diagrams. $10.

Mr. Thompson's book, as its name implies, is a report, or rather a review, of the Taylor system of management, with an account of some of the results that have been accomplished and a discussion of methods to be pursued in securing results with this system. His findings are based upon his own long and intimate experience with scientific management, supplemented by a personal investigation, covering a large part of four years, of nearly all the installations of the Taylor system in this country prior to 1915.

Considerable of the subject-matter has appeared in the magazines *System* and *Factory*, and in The Library of Factory Management. All of this matter has been thoroughly edited and revised. The aim of the author has been to make clear the differences between the Taylor system of management and other systems, and to present in a clear manner the general principles and most important mechanisms of the Taylor system as found in actual practice. It would appear that he has succeeded admirably in accomplishing his purpose. The book is tastefully illustrated and liberally provided with marginal notes that are helpful in grasping the most important parts of the discussion. It is bound in manual form, and provision is made for comments and memoranda by the reader.

The discussion is non-technical in character, and is written in a simple, readable manner, the aim being apparently to present the Taylor system clearly to those who know little about it, and to managers who may be desirous of finding out more concerning it with a view of installing efficiency methods. It is suited, therefore, to elementary students of efficiency methods, factory managers, and superintendents and general readers who are curious concerning the Taylor system, but who have neither the patience nor preparation to read Mr. Taylor's original writings.

The book is naturally somewhat biased in favor of the Taylor methods, and, like many books on this or other modern efficiency systems, it is liable to give the impression that all that is good in modern management came in with these modern methods. It hardly makes clear that many of the ideas and mechanisms employed by Mr. Taylor and his contemporaries in this work were in actual use before they launched their crusade.

However, Mr. Thompson makes some very convincing arguments, and his statements concerning the number of installations that have been successful, and his analysis of the reasons why some of them have failed, are well worth considering. Aside from this, also, the book will be interesting reading to those who are well informed on these matters, as it is the statement of one who has had long and intimate connection with the Taylor methods.

DEXTER S. KIMBALL.

Applied Motion Study. A Collection of Papers on the Efficient Method To Industrial Preparedness. By Frank B. Gilbreth, Mem.Am.Soc.-M.E., and Lillian M. Gilbreth, Ph.D. Sturgis & Walton Co., New York, 1917. Cloth, 5x7½ in., 220 pp., 17 illustrations and 1 folding chart. $1.50 net.

This book, as its subtitle implies, is a collection of papers presented by the authors before different scientific societies or printed in the Annals of the American Academy of Political and Social Science. The titles of the several papers are: 1. What Scientific Management Means to America's Industrial Position. 2. Units, Methods and Devices of Measurement Under Scientific Management. 3. Motion Study as an Industrial Opportunity. 4. Motion-Study and Time-Study Instruments of Precision. 5. Chronocyclegraph Motion Devices for Measuring Achievement. 6. Motion Models: Their Use in the Transference of Experience. 7. Motion Study for the Crippled Soldier. 8. The Practice of Scientific Management. 9. The Three-Position Plan of Promotion. 10. The Effect of Motion Study upon the Workers.

Mr. (now Major) Gilbreth is the father of modern motion study. He began it on July 12, 1885, when he studied the motions of two expert bricklayers who undertook to teach him their trade. He has been studying motions ever since, and now holds a commission as Major in the U. S. Army, with the special duty of utilizing motion study in the training of crippled soldiers for productive work and in modifying and adapting the work to the capabilities of the cripple. We quote the following from an introduction by Mr. George Iles:

> This is a book written from the heart as well as from the brain. Its good will is as evident as its good sense. Frank B. Gilbreth is a versatile engineer, an untiring observer, an ingenious inventor, an economist to the tips of his fingers: first and chiefly he is a man. To his wife, co-author with him, this book owes much. Every page has taken form with the aid and counsel of Mrs. Gilbreth, whose Psychology of Management is a golden gift to industrial philosophy. And thus, by viewing their facts from two distinct angles we learn how vital phases of industrial economy present themselves to a man and a woman who are among the acutest investigators of our time.

The greater part of the book is devoted to descriptions, in popular style, of the several inventions that have facilitated motion study. The following, in the words of the authors, is a brief outline of these descriptions:

> Scientific management is simply management that is based upon actual measurement.
>
> Motion study, time study, micromotion study, fatigue study and cost study are important measures of scientific management.
>
> Micromotion study consists of recording the speed simultaneously with a two- or three-dimensional path of motion by the aid of cinematograph pictures of a worker and a clock that shows divisions of time so minute as to indicate a different time of day in each picture in the cinematograph film.
>
> Motion study consists of dividing work into the most funda-

idental units possible; showing these elements separately and in relation to one another, and from these studied elements when timed, building methods of least waste.

The chronocyclegraph method of making motion study consists of fastening electric-light bulbs to the fingers, or to any part of the operator or of the material whose motion path it is desired to study. If the direction, relative time and relative speed are to be noted, the path of light, through controlled interruptions of the current, is made to consist of dots or dashes, or a combination of the two, with angle-pointed ends, the point showing the direction. Through the micromotion studies and the chronocyclegraph studies the expert formulates the standard method.

By taking the photograph stereoscopically we were able to see this path in three dimensions, and to obtain what we have called the stereocyclegraph. The time element is obtained by putting an interrupter in the light circuit that causes the light to flash at a known number of times per second. This gives a line of time spots in the picture instead of a continuous cyclegraph light line. Counting the light spots tells the time consumed.

The next step was . . . to find the right combination of volts and amperes for the light circuit and the thickness of filament for the lamp to cause quick lighting and slow extinguishing of the lamp. This right combination makes the light spots pointed on their latest, or forward, ends.

The points, thus, like the usual symbol of arrow heads, show the direction. The result was then, of course, stereochronocyclegraphs showing direction.

Wire models of cyclegraphs and chronocyclegraphs of the paths and the times of motions are now constructed that have a practical educational value besides their importance as scientific records.

We have a double cinematograph, that one part may record while the other moves from one exposure to the next.

For such cases [where there is an objection to the presence of an observer] we have designed an automicromotion study which consists of an instantaneous modification of the standard micromotion apparatus, and also the autostereochronocyclegraph apparatus. This enables the operator to take accurate time study of himself.

Through a method of using the same motion-picture film over and over again up to sixteen times . . . we have been enabled to cut down the cost of making time and motion study, until now the most accurate type of studies, involving no human equation in the record, can be made at less cost than the far less accurate stop-watch study.

The penetrating screen makes it easier to visualize and to measure the elements of the cycle being studied. A cross-sectioned screen of known dimensions can be introduced at any place where it will enable one to secure a more accurate record of the motion.

The data ascertained by these motion devices are placed on the simultaneous motion cycle chart. This analyzes a motion cycle into its component parts, and indicates graphically by which member of the body, and in what method, each portion of the cycle is performed. By the comparison of the analyzed motion model with the data on the chart, the possibility of the transfer of work from one working member of the body to another is indicated. The simultaneous motion cycle chart....has been presented by the writers for the benefit of the crippled soldiers in whose interests they are at present engaged.

We heartily commend this book to the attention of all those who are interested in the latest developments in scientific management, and especially in that branch of it that relates to the elimination of waste motion. The book, being merely a collection of papers and addresses, lacks, of course, the unity and systematic method of a logical and scientific treatise, such as it is to be hoped the Gilbreths may publish after the war is over, when they may find the time for its preparation.

A "final note," at the end of the book, informs us that the authors requested that it be printed in accordance with the forms of spelling recommended by the Simplified Spelling Board, but the publishers ruled otherwise. We congratulate the publishers upon their ruling. The authors are geniuses, of course, and must be allowed to have some of the eccentricities of genius, but they should not be allowed to give offense to their readers by flinging reformed spelling at them. If they wish to save ink and paper they can save a hundredth of one per cent by reformed spelling, but they can save a thousand times as much by blue-penciling their manuscript and cutting out ten per cent of it, and the "boiling down" would improve its quality.

WILLIAM KENT.

The American Year Book: A Record of Events and Progress for 1917. Edited by Francis G. Wickware, B.A., B.Sc., with the cooperation of a supervisory board representing national learned societies. D. Appleton & Co., New York and London, 1918. Cloth, 5x7⅝ in., xx+822 pp. $3 net.

In the present edition of this important and comprehensive digest, that which has been accomplished during the past year in the great departments of learning and human activity—history, politics, government, legislation, foreign relations, industry, science, engineering, the arts, the professions, literature, etc.—has been tersely reported by the members of a board consisting of over 100 accredited representatives or members of some forty American learned and scientific societies. The 31 sections of the work include articles on hundreds of topics, many of them relating to the war, ready reference to which is afforded by an extensive index containing nearly 6000 items. Section XXII, devoted to engineering, comprises 34 pages, eleven of which deal with progress in the field of mechanical engineering, and were contributed by Messrs. Calvin W. Rice, Secretary of the A.S.M.E., and Leon Cammen, associate editor of THE JOURNAL.

LIBRARY ACCESSIONS

ACTIVATED SLUDGE PROCESS OF SEWAGE TREATMENT. A bibliography of the subject. By J. Edward Porter. *Rochester, 1917.* Gift of General Filtration Company.

THE ALDRICH MARINE DIRECTORY, Containing (A) List of Concerns which Build and Repair Vessels, (B) List of Steamship, Steamboat and other Vessel Owners Using the American Flag. Aldrich Publishing Co., *New York, 1918.* Flexible cloth, 8 x 4 in., 220 pp. $5. Gift of the publisher.

AUTOMOBILE STARTING, LIGHTING AND IGNITION. By Victor W. Pagé. A Complete Exposition Explaining all Forms of Electrical Ignition Systems Used with Internal Combustion Engines of all Types, also Including a Comprehensive Series of Instructions Pertaining to Starting and Lighting Systems of Automobiles. 4th ed., revised. The Norman W. Henley Publishing Co., *New York, 1918.* Flexible cloth, 5 x 8 in., 519 pp., 298 illus., $1.50. Gift of the publisher.

AVIATION ENGINES. By Victor W. Pagé. Design, Construction, Operation and Repair. A Complete, Practical Treatise Outlining Clearly the Elements of Internal Combustion Engineering with Special Reference to the Design, Construction, Operation and Repair of Airplane Power Plants; also the Auxiliary Engine Systems, such as Lubrication, Carburetion, Ignition and Cooling. It Includes Complete Instructions for Engine Repairing and Systematic Location of Troubles, Tool Equipment and Use of Tools, also Outlines the Latest Mechanical Processes. The Norman W. Henley Publishing Co., *New York, 1918.* Cloth, 6 x 9 in., 589 pp., 253 illus., $3. Gift of the publisher.

AVIATION POCKET BOOK FOR 1917. By R. Borlas Matthews. *London, 1917.* Purchase.

AXIAL ABERRATIONS OF LENSES. (U. S. Bureau of Standards. Scientific Papers, no. 311.) *Washington, 1917.* Purchase.

CENTRAL STATIONS. By Terrell Croft. McGraw-Hill Book Co., Inc., *New York, 1917.* Cloth, 6 x 8 in., 332 pp., 306 illus., $2.50. Gift of the publisher.

COLORADO. Mining map showing the distribution of the main geological periods from the Archean to the Tertiary with the occurrence of the various metals therein and some of the non-metals, as oil, coal, etc., compiled by R. L. Chase. Gift of Bradley Stoughton.

COMPARATIVE TESTS OF PORCELAIN LABORATORY WARE. (U. S. Bureau of Standards. Technologic Papers, no. 105.) *Washington, 1917.* Purchase.

CONTINUOUS-CURRENT MOTORS AND CONTROL APPARATUS. By W. Perren Maycock. A Practical Book for all Classes of Technical Readers. Whittaker & Co., *New York, 1917.* Cloth, 8 x 5 in., 331 pp., 150 illus., $2.25. Gift of the Macmillan Co.

CORRECTION TABLES FOR THERMODYNAMIC EFFICIENCY. Calculated by C. H. Naylor. *London, 1917.* Purchase.

CREOSOTED WOOD STAVE PIPE AND ITS EFFECT UPON WATER FOR DOMESTIC AND IRRIGATION USES. (University of Washington, Bureau of Industrial Research. Bulletin No. 1.) *Seattle, 1917.* Gift of University of Washington.

DESCRIPTIVE GEOMETRY. By Ervin Kenison and Harry Cyrus Bradley. The Macmillan Company, *New York, 1917.* Cloth, 5 x 8 in., 287 pp., 332 illus., $2. Gift of the publisher.

DETERMINATION OF ABSOLUTE VISCOSITY BY SHORT TUBE VISCOSIMETERS. (U. S. Bureau of Standards. Technologic Papers, no. 100). *Washington, 1917.* Purchase.

DISTRICT HEATING. By S. Morgan Bushnell and Fred. B. Orr. A Brief Exposition of the Development of District Heating and its Position among Public Utilities. Heating and Ventilating Magazine Co., *New York, 1915.* Cloth, 6 x 9 in., 290 pp., 82 illus., 1 por., $3. Gift of the publisher.

DRYING CLAY WARES. By Ellis Lovejoy. T. A. Randall & Co., *Indianapolis,* (copyright, *1916.*) Cloth, 6 x 9 in., 166 pp., 86 illus., $2. Gift of the publisher.

DURABILITY OF CEMENT DRAINTILE AND CONCRETE IN ALKALI SOILS, CONTAINING RESULTS OF THIRD YEAR'S TESTS. (U. S. Bureau of Standards Technologic Papers no. 95.) *Washington, 1917.* Purchase.

EFFECTS OF HEAT ON CELLULOID AND SIMILAR MATERIALS. (U. S. Bureau of Standards. Technologic Papers, no. 98.) *Washington, 1917.* Purchase.

ELEMENTS OF PLUMBING. By Samuel Edward Dibble. McGraw-Hill Book Co., Inc., *New York, 1918.* Cloth, 5 x 7 in., 170 pp., 83 illus., $1.50. Gift of the publisher.

ENZYMES AND THEIR APPLICATIONS. By Dr. Jean Effront. English translation by Samuel C. Prescott. John Wiley & Sons, Inc., *New York,* (copyright *1902*). Cloth, 6 x 9 in., 332 pp., $3. Gift of the publisher.

EXPERIMENTAL RESEARCH ON AIR PROPELLERS. (National Advisory Committee for Aeronautics. Report no. 14.) *Washington, 1917.* Gift of National Advisory Committee for Aeronautics.

EYE HAZARDS IN INDUSTRIAL OCCUPATIONS. By G. L. Berry. *New York, 1917.* Gift of National Committee for the Prevention of Blindness.

FINDING AND STOPPING WASTE IN MODERN BOILER ROOMS. Vol. 2. A Reference Manual to Aid the Owner, Manager and Boiler Room Operator in Securing and Maintaining Plant Economy. Harrison Safety Boiler Works, *Philadelphia, 1918.* Linen, 5 x 7 in., 274 pp., 120 illus., $1. Gift of the publisher.

FIRING BITUMINOUS COALS IN LARGE HOUSE-HEATING BOILERS. (U. S. Bureau of Mines. Technical paper 180.) *Washington, 1917.* Purchase.

FRENCH FORESTS AND FORESTRY. By Theodore S. Woolsey, Jr. Tunisia, Algeria, Corsica with a Translation of the Algerian Code of 1903. John Wiley & Sons, Inc., *New York, 1917.* Cloth, 6 x 9 in., 238 pp., 20 illus., $2.50. Gift of the publisher.

GREAT BRITAIN. DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH. ADVISORY COUNCIL. Report on the resources and production of iron ores and other principal metalliferous ores used in the iron and steel industry of the United Kingdom. *London, 1917.* Purchase.

GYPSUM PRODUCTS, THEIR PREPARATION AND USES. (U. S. Bureau of Mines. Technical paper 155.) *Washington, 1917.* Purchase.

HEAT DROP TABLES, ABSOLUTE PRESSURES. By Herbert Moss, from the formulæ and steam tables of H. L. Callendar. *London, 1917.* Purchase.

KINEMATICS OF MACHINERY. By Arthur Warner Klein. A Text-Book on Mechanisms and their Properties with Many Practical Applications for Engineers and for Students in Technical Schools. McGraw-Hill Book Co., Inc., *New York, 1917.* Cloth, 6 x 9 in., 227 pp., 118 illus., 7 diagrams, $2.50. Gift of the publisher.

L'ABATTOIR MODERNE, CONSTRUCTION, INSTALLATION, ADMINISTRATION. By A. Moreau. Ed. 2. *Paris, 1916.* Purchase.

LATENT HEAT OF PRESSURE VARIATION OF LIQUID AMMONIA. (U. S. Bureau of Standards. Scientific Papers no. 314.) *Washington, 1917.* Purchase.

LE MOTEUR A EXPLOSIONS. By René Devillers. *Paris, 1917.* Purchase.

LUFT-FAHRTEN NACHSCHLAGEBUCH, 1915. In Russian. By K. E. Vejgelin. *Petrograd, 1915.* Purchase.

MEASUREMENT OF GAS BY ORIFICE METER. By Henry P. Westcott. Metric Metal Works. *Erie, 1918.* Cloth, 8 x 5 in., 408 pp., 35 illus., tab., $3.50. Gift of the publisher.

METER RATES FOR WATER WORKS. By Allen Hazen. John Wiley & Sons, Inc., *New York, 1918.* Cloth, 6 x 9 in., 217 pp., 21 illus., $2.25. Gift of the publisher.

METHODS FOR INCREASING THE RECOVERY FROM OIL SANDS. (U. S. Bureau of Mines. Bulletin 148.) *Washington, 1917.* Purchase.

MODEL AEROPLANES AND THEIR ENGINES. By George A. Cavanagh. A Practical Book for Beginners. Drawings by Harry G. Schultz, with an introduction by Henry Woodhouse. Moffat, Yard & Company, *New York, 1917.* Cloth, 5 x 8 in., 152 pp., 20 illus., 19 pl., $1. Gift of the publisher.

NOTES ON MILITARY EXPLOSIVES. By Erasmus Weaver. 4th ed., revised and enlarged. John Wiley & Sons, Inc., *New York, 1917.* Cloth, 6 x 9 in., 382 pp., $3.25. Gift of the publisher.

OPTIC PROJECTION. By Simon Henry Gage and Henry Phelps Gage. Principles, Installation and Use of the Magic Lantern, Projection Microscope, Reflecting Lantern, Moving Picture Machine. Comstock Publishing Co., *Ithaca, 1914.* Cloth, 6 x 9 in., 731 pp., 413 illus., $3. Gift of the publisher.

PAINT AND VARNISH. (U. S. Bureau of Standards. Circular, no. 69.) *Washington, 1917.* Purchase.

POWER WIRING DIAGRAMS. By A. T. Dover. A Handbook of Connection Diagrams of Control and Protective Systems for Industrial Plants. Whittaker & Co., *New York, 1917.* Cloth, 4 x 7 in., 208 pp., 254 illus., $2.25. Gift of the Macmillan Co.

PUBLIC UTILITY SERVICE STANDARDS OF QUALITY AND SAFETY. (U. S. Bureau of Standards. Circular no. 68.) *Washington, 1917.* Purchase.

THE PRINCIPLES OF ECONOMIC GEOLOGY. By William Harvey Emmons. McGraw-Hill Book Co., Inc., *New York, 1918.* Cloth, 6 x 9 in., 606 pp., 210 illus., $4. Gift of the publisher.

A SHORT HISTORY OF SCIENCE. By W. T. Sedgwick and H. W. Tyler. The Macmillan Company, *New York, 1917.* Cloth, 6 x 9 in., 474 pp., $2.50. Gift of the publisher.

STATISTICS. By William B. Bailey and John Cummings. A. C. McClurg & Co., *Chicago, 1917.* Cloth, 4 x 7 in., 153 pp., 60 cts. Gift of the publisher.

SYMBOLS FOR MECHANICS AND HYDRAULICS. By John T. Faig. Reprinted from Bull. of the Society for the Promotion of Engineering Education, vol. VIII, *1917.* Gift of author.

TECHNICAL BOOK REVIEW INDEX. 1917. Carnegie Library. *Pittsburgh, 1917.* Purchase.

TECHNICAL HANDBOOK OF OILS, FATS AND WAXES. By P. J. Fryer and F. E. Weston. *Cambridge, 1917.* Purchase.

TESTING FOR THE FLOTATION PROCESS. By A. W. Fahrenwald. John Wiley & Sons, Inc., *New York, 1917.* Leather, 4 x 7 in., 173 pp., 34 illus., $1.50. Gift of the publisher.

TREATISE ON ELECTRICITY. By F. B. Pidduck. *Cambridge, 1916.* Purchase.

WASHINGTON UNIVERSITY, ST. LOUIS. Catalogue, 61st, 1917. *St. Louis, 1917.* Gift of University.

WATERTIGHT CONCRETE. (Bulletin F-3, Hydrated Lime Bureau of the National Lime Manufacturers' Association.) *Pittsburgh, 1917.* Gift of National Lime Manufacturers' Association.

WATT AND THE STEAM AGE. By John W. Grant. *London, 1917.* Purchase.